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ABSTRACT

This collection presents papers pertaining to the wide area of educational multimedia/hypermedia and telecommunications. The conference serves as a forum for the dissemination of information on the research, development, and applications in all areas of multimedia/hypermedia and telecommunications in education across all disciplines and levels. The papers cover a range of topics, including specific uses of several different technologies in distance and on-site education; design and implementation; and program and software evaluation. These proceedings contain 178 full papers, reports of 6 panel discussions, 149 short papers, and reports of 50 posters and demonstrations. (AEF)

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ED 414 891

Educational Multimedia/Hypermedia and Telecommunications, 1997

Volume I

edited by
Tomasz Müldner
Thomas C. Reeves

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World Conference on Educational Multimedia/Hypermedia
World Conference on Educational Telecommunications
Proceedings

University of Calgary; Calgary, CANADA; June 14-19, 1997

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Educational Multimedia/Hypermedia and Telecommunications, 1997

Volume I

edited by
Tomasz Müldner
Thomas C. Reeves

ED-MEDIA/ED-TELECOM 97
World Conference on Educational Multimedia/Hypermedia
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Proceedings
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PREFACE

Welcome to ED-MEDIA/ED-TELECOM 97 in beautiful Calgary, Alberta, CANADA. It is fitting that this tenth in a series of research and development conferences is being held in the same city that hosted the first meeting, the International Conference on Computers and Learning (ICCAL) in 1987. Over the last decade, thanks largely to the efforts of scores of volunteers, ED-MEDIA/ED-TELECOM has become one of the top events of its kind anywhere in the world. An annual event since 1993 when the conference became associated with the Association for the Advancement of Computing in Education (AACE), ED-MEDIA/ED-TELECOM retains many valued aspects of the earlier conferences, most importantly the truly international nature of its participants. At the same time, the conference has grown in sophistication and scope, and we hope that you will find that this year's version lives up both to your memories and your expectations.

In areas as heavily invested in innovation as educational multimedia, hypermedia, and telecommunications, some might question the meaning and value of holding face-to-face conferences for which presentations must be submitted and prepared months in advance. After all, changes in the technologies we employ occur at a faster and faster pace, and last month's cutting-edge news is this month's dull topic. However, most of us recognize that as conference participants we are not so much interested in technologies as ideas. New ideas are often shared, critiqued, and reshaped through personal dialogue and group discussion. Further, we recognize that many of the most important exchanges that take place at professional meetings occur away from formal sessions. Collegial introductions at social events as well as chance meetings in the hall where you make new friends and catch up with old ones, these and many other human interactions are often the most valued and long-remembered aspects of any conference. Although the global "infocasm" described by futurists suggests otherwise, we predict that the basic human need to interact face-to-face will last far into the 21st Century.

As co-chairs of the Program Committee (PC), we have endeavored to increase the quality of the papers, tutorials, workshops, posters, demonstrations, panels, showcases and other events at this year's conference. We could not have done this without the hard work of the PC members listed on the following pages. Representing nearly twenty different countries, these individuals reviewed more proposals than ever before. The papers in this volume and on the accompanying CD-ROM survived several rounds of demanding analysis, critique, and selection, as did the other types of sessions. In addition, the counsel of the Steering Committee members was invaluable, especially in terms of selecting the keynote and invited speakers. Gratitude also goes to the AACE team, most notably Executive Director Gary Marks. Finally, we acknowledge the many and varied efforts of the Local Executive Committee in Calgary, co-chaired by Brian Gaines and Douglas Norrie, of the University of Calgary, our host institution. Thank you one and all.

A year of preparation will soon be over, and ED-MEDIA/ED-TELECOM 97 will be a memory. It is our hope that this memory will be refreshed each time you open this volume or access the conference CD-ROM, seeking information and inspiration for your future work. Further evidence of that living memory will be your continued participation in this event. To that end, we look forward to seeing you again next year at ED-MEDIA/ED-TELECOM 98 in Freiburg, Germany.

Tomasz Müldner
Acadia University, CANADA
Thomas C. Reeves,
The University of Georgia, USA

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FULL PAPERS

The Effects of Structure on Hypertext Design

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Abstract[1]

This paper examines the effects of structure on the effectiveness of a relatively large hypertext system. CS 383 consists of 300 pages of course hypertext with 178 cross references, 678 terms with pop-up definitions, and 600 terms that students can search on. Two hypertext systems based on this course material and consisting of the same content were compared. The first system was the originally developed system and its structure was based on the course schedule. The second system was based on an object decomposition of the same material. Using a sample population of thirty-two students, the two systems were compared in terms of the effectiveness of the hypertext structure. The results indicate that object decomposition enhanced student performance on the exam but increased the amount of time required to complete the exam and the number of nodes visited. Given that enhancing student performance is a primary goal of education, the object decomposition-based hypertext provides a valid approach to designing and structuring educational hypertext.

Introduction

Background and the Problem

Beginning in 1994, CS383, Computer Systems, has provided access to over 1.2 gigabytes of course material through the World Wide Web (WWW). Hypermedia CS383 provides a vast array of media elements to support the transfer of information. The hypermedia course provides extensive resources such as: 143 audio files; 63 graphic files; 57 digital movies; instructor slideshows for every lesson; lesson objectives color-coded by Bloom's Taxonomy; note-taking guides; a course digital library system with over 470 student papers and slideshows from previous semesters; 300 pages of course hypertext with 178 cross references, 678 terms with pop-up definitions, and 600 terms that students can search on; an adaptive hypermedia interface that adapts the student's interface to the student's learning style; a Java and JavaScript-based for building and testing a virtual computer; and a DOOM scenario for administering cooperative quizzes in the classroom [Carver & Gregory 1995a, Carver & Biehler 1994a, Carver et al. 1995a, Carver et al. 1996a, Carver and Ring 1996a]. Through these components, Hypermedia CS383 attempts to enhance the educational resources available to the student outside of the classroom.

One of the key components CS383 is the course hypertext. Initially developed as a Microsoft Windows help file, this tool proved extremely popular with course students and typically students ranked it as one of the best tools in the course for learning (see Figure 1). The conversion of the help file to a WWW frame-based document provided the opportunity to re-examine the underlying structure of the hypertext. Given the popularity of the tool, optimization of the hypertext would maximize the effectiveness of student study.

The initial development of the hypertext was thorough yet only loosely structured around course lesson objectives and the course schedule. Research in hypertext development have suggested that object decomposition of the hypertext would facilitate student learning [Adams 1995a, Nanard and Nanard 1991a, Schwabe et al. 1996a].

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[1] The views expressed in this paper do not represent the official position of the United States Military Academy, the US Army or the Department of Defense. All insights are the authors' own.

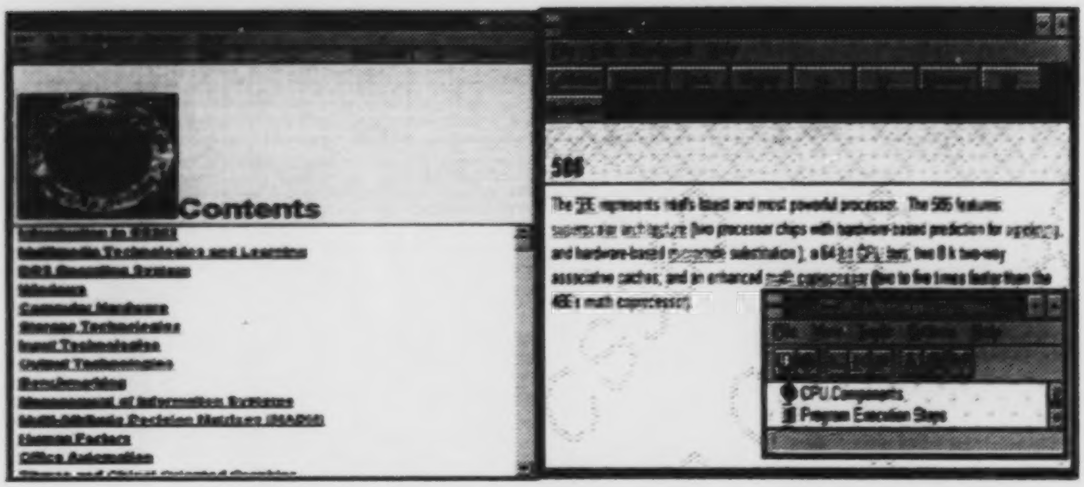

Figure 1: The User Interface into CS383 Hypertext and an Example Page

The Solution

During the Spring Semester of 1996, then a second version of the course hypertext was developed based on object decomposition. The content of both versions remained the identical; only the structure of the hypertext was altered. Both versions were then evaluated in terms of: student correctness on a ten-question exam; number of nodes visited; and time to complete the informational searches required to complete the exam.

Previous Work

Previous work has proposed methodologies for the development of object-based hypertext [Adams 1994, Nanard and Nanard 1991a, Schwabe et al. 1996a] without assessing the effectiveness of the proposed system. Other research has provided a subjective assessment of the effectiveness of the hypertext without quantitative proof [Carver & Howard 1995a, Ess 1991a, Landow 19??a]. Still other work have provided a quantitative assessment but used arbitrary segment decomposition instead of a structured approach such as object- or schedule-based decomposition as the basis for the study [Dee-Lucas 1996a, Dee-Lucas 1995a]. None of these works have examined quantitatively the effects of object-based structure on student performance using the system. In this regard, this work is significantly different from previous work in the field.

Methodology

Background

Both versions of the hypertext were developed using Wex-Tech Doc-to-Help. This forced certain constraints such as:

- The hypertext had a maximum of four levels.
- Due to the size of the hypertext, there was a maximum of twenty level one headings.
- The cross references within the hypertext can only point internal to their parent level one heading because each major section was a separate file [Wex-Tech 1995a].

The first constraint, only four levels of hypertext, had limited impact as providing more than four levels of hypertext would have increased the likelihood of user disorientation [Haga and Nishino, 1995a]. The second constraint, a maximum of twenty level one headings, likewise had limited effect as the course had only twenty-two major topics. Two of these topics were combined into related lessons. The last constraint, no cross references between level one headings, did have a major impact on the effectiveness of the hypertext. Often there were relationships between the course material in different level one headings but these relationships could not be connected through a cross reference because Word for Windows, the source of the help file, does not support cross references between files. Frequently, a text-based cross reference was provided so that the student could manually refer to the related material.

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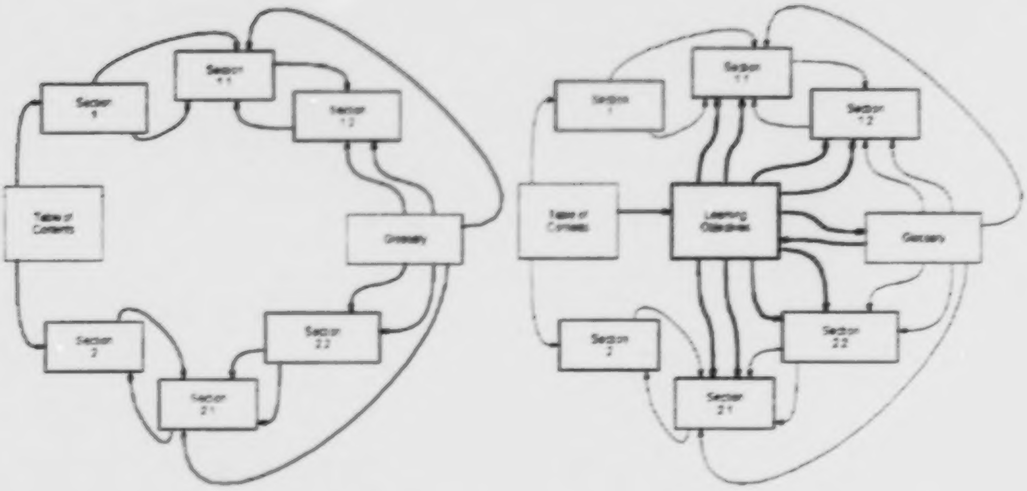

Figure 2: Course Hypertext Structure: Before and After

Using Doc-to-Help, two systems were developed to evaluate the effect of hypertext structure on student performance.

The original course schedule-based hypertext (CSBH) was structured according to the course schedule (see Figure 2.) Related lessons that occurred near each other were grouped together under a level one heading. Cross references between related material were built within the same level one heading. No cross references could be built between related course material in different level one headings. All four levels of the hypertext structure were used .

The structure of the second version (see Figure 2) was object oriented text decomposition based hypertext (OOTDH) [Talbert and Umpress 1989].

Restructuring The Hypertext

OOTD uses object decomposition to develop a hierarchy of relationships between concepts in the material. As a main concept is decomposed, the explicit relationships serve as links between the conceptual components. OOTD forces a hypertext creator to rethink several key development issues:

- How do I expect students to access this concept?
- What level of detail is needed at this level of abstraction?
- Can the student access material which supports or expands on this concept directly, or do they have to navigate through different hierarchical levels?

In an effort to assist a hypertext creator in systematically considering these issues, a methodology was developed which used OOTD and a set of graphical maps to depict the hypertext structure [Adams 1994]. Once concepts were decomposed into concept relationship pairs, these were displayed on an OOTD graph. Next, take the outline of the material (a hierarchical representation of the material) and display that in a graph form called a primitive linking (PL) graph. Combine the OOTD and PL graphs to create an initial system map or flowchart. At this point the explicit or first order links [Rada 1992] are displayed on the system map. The next step requires the hypertext's designer to portray the implicit relationships between concepts.

These implicit relationships sometimes appear in printed text as "See Section 1.23 for more details" or "Refer to Chapter 12". They are often the part of hypertext development that is not implemented because of the difficulty in tracking the links created by thoroughly cross referencing the material. By graphically portraying the cross references as well as the hierarchical links, a complete system map was developed.

This methodology had been used to create new Computer Assisted Instruction (CAI) material [Adams and Mengel 1996] but never to re-engineer an existing hypertext. A student group was recruited to re-engineer the CSBH using the aforementioned methodology. They began by completely mapping the relationships and links in the CSBH. They then created a thesis statement for the material in the

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CSBH and designed a new structure for the hypertext. Using the Word for Windows documents that had served as the source for the CSBH and Doc-to-Help, the student group re-organized and re-linked the material. This effort ensured that the material did not change, only its linking structure.

The changes to the structure are calculated by measuring the Relative Out Centrality (ROC) of the hypertext system [Botofogo, et. al. 1992.] Briefly, a node's ROC is a measurement of that node's accessibility. The lower a node's ROC, the more accessible it is to the user. Hypertexts with high ROCs can have the problem of isolating information, i.e., constructing link paths that make it difficult for a user to locate and use information. A comparison of the ROCs of the CSBH and the OOTDH is shown in Figure 3.

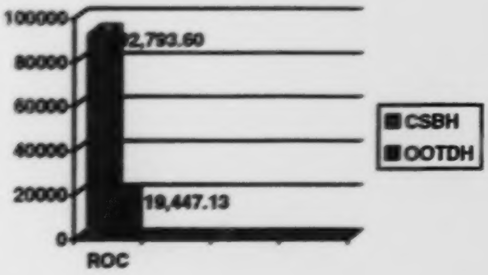

Figure 3 Comparison of Relative Out Centrality

Assessment Of Structure Effectiveness

Thirty-two students completed a timed evaluation of ten questions using the original hypertext and the hypertext. The students were timed in answering the questions, the number of nodes they visited were recorded, and the evaluations were then graded. The sample population of thirty-two students were divided into two groups: one which used the original hypertext and a second which used the hypertext based on object decomposition.

Results

There are two environmental factors that influence the results. First, the evaluation was given at the end of the semester and most of the students were comfortable using the CSBH while they had never used the OOTDH. Second, because it was the end of the semester, the students were also very familiar with the course schedule. These environmental factors should favor the CSBH over the OOTDH. Despite this bias, students using the OOTDH outperformed the students using the CSBH in certain tasks.

The students answered significantly more questions correctly using the object decomposition-based hypertext as compared to the course schedule-based hypertext. The students were correct 76.875% of the time using the OOTDH and were only 70% correct using the CSBH (See Table 1). Of the ten questions on the exam, students were more correct on five questions out of ten using the OOTDH, and were more correct using the CSBH on only two questions. Given that an increase in performance on a quantitative exam is a fundamental indicator that the students are learning more, the OOTDH provides a better structure than CSBH for pedagogical purposes.

This increase in correctness in performance is likely a result of the object decomposition. While both systems provide a deductive decomposition of information, the OOTDH system is more orthogonal and provides a finer granularity of knowledge representation.

OOTDH is more orthogonal in the decomposition of the course material than CSBH. Object decomposition provides a consistent framework for breaking the course material into manageable and interrelated nodes. CSBH is, at best, a loosely structured system with the determination of nodes and links decided by the professor. While the CSBH will more closely model instructor presentation of the course material, it may not portray the all of the links between course material and the number and size of nodes is arbitrary.

The arbitrary size of nodes in the CSBH system likewise affected student performance on the assessment. While there is no set size for nodes in a CSBH or OOTDH system, the OOTDH methodology often results in smaller nodes due to the object decomposition process. While this may lengthen the amount of time required to find the information, the fine granularity of the found information make it easier for the students to discern the correct answer. In terms of correctness, the advantages of the OOTDH outweighed the advantages offered by the CSBH.

Measurement	Course Structure-based Hypertext	Object Decomposition-based Hypertext
Correctness on exam (%)	70	76.875
Average time to complete a question (seconds)	67.279	84.631
Average number of nodes visited	4.913	5.107

Table 1. Summary of Results from Hypertext Evaluation

In terms of time and nodes, however, the students took more time to find their answer (67.279 versus 84.631 seconds) and followed more links (5.107 versus 4.913 links), on average, using the OOTDH as compared to the CSBH. This is likely a result of the close correlation between the student's mental model of the course material and the structure of the hypertext. The student mental mode of the course material is formed based the structure of the course and the presentation of the course material. Since the structure of the CSBH is based on the course structure, it closely matches the mental model of most students. Furthermore, as mentioned above, the students in the assessment had used the CSBH system throughout the semester and were familiar both with the course structure and the CSBH. This likely would decrease the number of nodes visited and the amount of time required to complete an exam question.

Summary And Future Work

Hypertext based on object decomposition enhances student performance on a exams but increases the amount of time required to complete the exam and the number of nodes visited. Subsequent testing is planned which is expected to show that familiarity with the OOTDH will decrease the amount of time required to locate desired information.

Future work is based on validating the effect of interface and network latency on hypertext effectiveness. This effort has spawned its own project which will be evaluating a distributed hypermedia product against a local hypermedia product and a standard text book.

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5 Protocols to Electronic Mentoring

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Abstract:

The factor that has most limited the development of a universal electronic mentor is that it is too large a task for any one group or institution to build. However, the web node model overcomes this largeness by allowing a very large number of people to collaborate. What they need to collaboration is 5 protocols that:

1) describe learning through hierarchical subgoals
2) standardize the learning interface of all nodes
3) describe the knowledge state of the mentee
4) describe context of the mentee's goal
5) keep a map of the return path through the hierarchy of goals.

Discovering five protocols

These protocols derive from any experience where completing the project required the learning of information. To complete the project you had to extract, assemble, and manipulate information from what you knew, and from a vast array of sources that included manuals, reference documents, peers, and classroom teachers. In that project, you succeeded but it nearly killed you.

Next time, what kind of help would you like? How about a little guy who sat on your shoulder and whispered short useful answers to your immediate questions. How about a little guy who would sit there all day and all night; waiting for you to ask never making you feel dumb or that your were wasting his time. How about a little guy that understood the problem you faced and the parts you already understood, and never wastes your time repeating what you already knew or adding extraneous information you didn't need. How about a little guy that was so smart he even knew when you could not understand the answer your needed. Instead of confusing you with gibberish he would say "you have to understand three things." We will work on understanding them first and use them to understand your question.

What you want is an ideal mentor

Forget for a moment that no single human being could be a universal expert in all bodies of knowledge. Forget that no single human could pay attention to your intellectual meanderings 24 hours a day for years. Forget the cost of paying an army of people who could perform such a task. And consider the list of capabilities that mentor or that army must have.

The ideal mentor lets the student set the initial goal, pick the time for learning, the pace of instruction, the duration of effort and not only allows random interruptions but reviews for the student the past progress at restart.

The ideal mentor knows everything and can logically and casually connect the mentee's objectives to first principles

The ideal mentor packages information so it:

1) is understandable with the knowledge the mentee already has,
2) appears useful in achieving the mentee's immediate goals. and
3) motivates progress through subgoals.

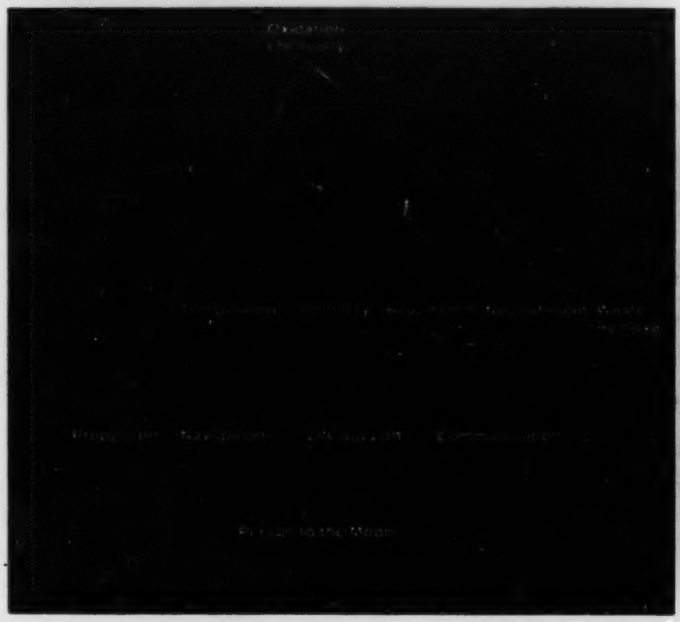
These packaging objectives are achieved by:

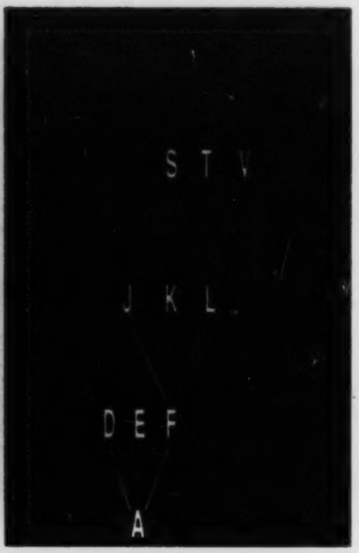
1) using a consistent and uniform presentation format
2) breaking complicated goals into smaller and smaller subgoals
   until the subgoals and their components are within the
   capabilities of the mentee.
3) limiting the content to the usable
   not broadening any explanation beyond that
   immediate framework created by the mentee.
      "The mentor has no syllabus."

To facilitate this packaging, the mentor must have two measures and a map. The first measure is of the mentee's knowledge. The second, measure is that of the context of the mentee's goal. Finally the mentor needs a map to get the packages to fit together. The map shows all the subgoals previously visited and a record of their partial completion. The map keeps the mentor on a path to solve the global goal.

From mentor theory to web mentor

How do we convert this theoretical description to a web implementation. Our question is, "What parts of this ideal mentor are already inherent in web design and what parts need implementation." Let me pose an example problem, and then by tracing pathways to and through some subgoals of that problem make explicit both what activities a mentor is performing and deduce the electronic equivalent of them. Consider a mentee's goal of sending a person to the moon.


Oxidation
Chemistry
Temperature Humidity Respiration Nourishment Waste
Removal
Propulsion Navigation Life Support Communication
Person to the Moon


S T V
J K L
D E F
A

The mentor creates some subgoals. For example propulsion, navigation, life support, communication, etc. The life support goal can be further broken down into more subgoals. For example, temperature, humidity, respiration, nourishment, waste removal etc.

In general the goal tree will appear like A is accomplished if , D, E and F are accomplished. F is accomplished if J, K, L are accomplished. L is accomplished if subgoals S, T, V are accomplished, etc. The branches above these subgoals eventually lead to the laws of nature. The leaves on these tiny branches are definitions of single words in a sentence or definitions of single variables in equations.

The student progresses upward in the tree until the information presented makes sense and can be used to solve the next lower subgoal.

While these nodes are shown as part of a single tree, think of each letter as a web node written and maintained by a single expert.

In real life, an oxidation chemist mentor could play a role in solving many parts of the "person to moon" global goal. For example there could be pointers from the nodes of respiration, nourishment and even more distant branches like propulsion.

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The oxidation chemist node being created independently of the man in the moon context, could also be pointed to from branches of trees representing other global goals. For example a heart transplant tree might have its blood gas branch pointing to the oxidation chemist node.

The operation of nodes

The node itself, must act like an expert mentor.

1) evaluate the mentee's current knowledge, and from this
    a) determine which group of subgoals if completed
    b) will allow the mentee to solve the super goal.
2) The node then facilitates the mentee's access to these subgoals.
    Finally the node must
3) verify its success. It has to know if it produced the understanding
required by the super node. If not, the node must create a remedial plan.

What the web can do

It is easy to see that the existing web structure accomplishes some of the impossible tasks in the ideal mentor list. For example the web can provide thousands of information sources. Make them accessible 24 hours a day to thousands of mentees. The web can present information using voice, text, symbols, pictures, animations, and simulations

Five problems to be solved

However, in its present state the web can not facilitate efficient mentor based learning To accomplish this it has to overcome 5 problems.

Problem 1 -- The nodes don't work together.

The designer of a node must find it easy to locate subnodes which efficiently support learning to complete the super goal. This efficiency can only be accomplished if the nodes are designed using the same learning model which explains how to break goals down into sub goals. Until this learning model exists each node maker will design his own, making it harder for others to use them. Each node designer will include activities that should be in a sub node with his node. That node will grow. The job of creating and maintaining such a large node will be difficult. Few if any will want to attempt it.

Thus to keep things distributed in small manageable nodes requires a protocol that tightly defines learning through hierarchical subgoals

Problem 2 – Non standard GUI

Students need a standard view of information that let's them navigate through their learning environment. That is they need to steer from topic to topic, parse confusing presentations, learn the supporting concepts, repeat an explanation, evaluate their comprehension and stop and restart their learning. The user interface must make this easy. If every node builder implements a unique interface, the mentee will have to learn the node's interface before starting on the node's content. The overhead will greatly reduce the electronic mentor's value. To prevent such hardship a second protocol is required which defines a single standard interface.

Problem 3 - node's ignorance of the mentee's knowledge

A third problem was created when we switched our mentor from a life long friend on our shoulder who was familiar with our unique objectives and capacities, to an army of independent mentors who are strangers. If each mentor has to start from scratch to establish our knowledge and capacities, valuable minutes and possible hours could pass before they could lay block one of their plan to help us.

The resolution of the third problem is the design of a byte code protocol that defines each user's capacities and knowledge. A byte code that could be read by each node and modified by each node when the mentee learns new knowledge.

Problem – 4 node's ignorance of the context of question

A fourth unresolved problem, is that a sub node needs the context of the super goal to do its job. What the little guy on your shoulder had, a lifetime of experience with the mentee, the sub node designer has to gain from an interview with the mentee. The resolution is a protocol that allows the super node to create a digital code for the problem's context. and passed this code to the subgoal with the mentee.

Problem 5 – no one is keeping track of the learning path

For hierarchical learning to work a sub node must know to which node to return the mentee to after it completes its work. Once returned to a super node that has several subnodes there must be a record of which of these sub goals have been completed and which remain yet to be done. To solve this problem you create fifth protocol which contains the address and completion information for each active node in the tree. This data structure resides in the head program, which is located on the individual's home computer or service provider server.

Summary

Thus we have come to the end of our story. What needs to be added to the existing web scaffolding are 5 protocols.

Protocols for:
1) describing learning through hierarchical subgoals
2) standardizing the learning interface of all nodes
3) describing the knowledge state of the mentee
4) describing context of the mentee's goal
5) keeping a map of the return path through the hierarchy of goals.

The factor that has most limited the development of a universal electronic mentor is that it is too large a task for any one group or institution to build. However, the web node model overcomes this largeness by allowing a very large number of people to collaborate. And what they need to collaboration are these 5 protocols.

Conclusions on the Analysis of User Requirements concerning the use of ICT in the Didactic Process

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Abstract: The co-operation of the Information and Communications Technologies (ICT) and the Educational Society, is deemed necessary for the adaptation and tuning of the didactic process in terms of pedagogical methodologies, school infrastructure, human resources utilisation and organisational restructuring. The use of ICT in the classroom should be viewed as a highly influencing tool that will support the educators' effort for interaction with their students, rather than as a technical exercise. The initial phases of the TRENDS project, which are described in this paper, resulted in a widely accepted common methodology, that complies with the international standards for determining the User Requirements in the Secondary Education. The major results emerged from this survey are presented here, as well as some common axes that deal with the application of ICT in the didactic process.

1. Introduction

It is nowadays more than evident that the rapid evolution of the Information and Communication Technologies (ICT) during last decade, along with the need for widespread distribution of knowledge, have necessitated the development of pioneering distance education services for the assistance of the didactic process. The collaboration of these two distinct worlds - Computer Science and Education - will result in the creation of a universal Education Society.

The distance education services are expected to find major fields of applications in the didactic process, since they attempt to exploit the benefits that ICT offers in Education, rather than make the educators and the trainees experts on ICT. Yet, the co-operation of these two communities is not straightforward. Experts from both worlds will have to participate in joint projects which will consider the needs and the trends of both sides and will end up with a unified distance learning environment. Such an environment must support multimedia information, such as plain or formatted text, still images, audio and video, especially since it is addressed to people with no experience in using computational environments in their professions. The new age of training via networking will aid the wide distribution of knowledge and the construction of live, virtual classrooms, as well as widely accessible databases of courses on various subjects. In these classrooms, the students will participate in the training process by inquiring or interacting with the educators, while the off-line courses will be accessed and played independently by the trainees.

A measure of success for a distance learning environment would be the use of computers not only as electronic typewriters and spreadsheets, but as research and educational tools. Another indication of success would be to see educators integrating their lectures with student interactive learning procedures, and learning how to intermix them effectively. Since they aim to serve many target groups of various interests and aspects, the distance learning environments should be user friendly and to cover subjects from multiple areas and also multiple levels of trainees. In order to achieve user friendliness, a serious task of a project is the Users Requirement Specification.

There have been significant projects in the area of Distance Education. In [Veen et al.] there is a review of a range of communication and information technology projects within and across European countries. Most of them describe the collaborative use of electronic mail between schools on an international level. Ruopp et al. ([Ruopp et al. 93]) describe an in depth and long term project called LabnNet which attempts to develop a community of practice among teachers for supporting each other's profession across the USA. Companies such as AT&T have become involved in the development of services under the guidance of experts. Attempts have also been made to quantify the benefits of such electronic information and communication services. For example, [Riel 94] provides evidence related to the development of the skills that employers wish to see in their new recruits.

2. The TRENDS project

The *TRaining Educators through Networks and Distributed Systems (TRENDS) Project* [Bouras et al. 96] aims at the in-service distance training of 2,400 school teachers in Secondary Education, on the "*use of Information Technology and Telematics in the learning process*", from six countries (400 per country) - France, Greece, Italy, Portugal, Spain and United Kingdom. The training process will be implemented by flexible and distance learning methods, through:

- The development and the use of an in-service, school-based training session, which will be based on multimedia telematics and existing, mature network technologies.
- The establishment and operation of a European Teachers' Training Network (ETTN), consisting of six interconnected "National Sites" (a Training Centre, clients in the schools and teachers in each country) and providing distance training services, by using multimedia telematics, to teachers and teacher trainers.

During the TRENDS project 120 teachers - one from each of the 120 participating schools - will be trained in the early validation phase, and will traine the rest of the 2,400 teachers afterwards, in the project demonstration phase. The evolution of a promising and ambitious experiment, such as the TRENDS project strongly depends on the strategy and the "Usage Scenario" that will be adopted. Thus, it is of great importance to specify the User Requirements effectively, covering the needs of both the direct users (educators who will participate in the project) and the indirect users (policy makers in the Education System, ICT experts, etc.).

3. Methodology for the User Requirements Specification

The target group of the TRENDS project is trans-European and consists of educators who will be trained on using Information Communication Technology (ICT) in the classroom. Some of the possible techniques that could be used for the establishment of the User Requirements of a trans-European project, according to a widely accepted methodology (eg. [Smith & Mayes 96]), are the following:

Personal interviews with the end users. This technique offers a useful way to investigate the User Needs in real life. The main problem is the enormous number of the end users, which might lead to prohibitive costs. A careful selection of a representative group of the initial target group of the project might aid such a procedure to be more practical and still effective.

Questionnaires. In order to keep the cost down, the use of custom designed questionnaires and surveys may prove a more practical option. The key point of this technique is the construction of the questionnaires, so as to be representative and to reflect all the possible user requests. The team that will construct the questionnaires must include specialists on the scientific areas that the project deals with, experts on technological issues, as well as representatives of the potential target group.

Organisation of discussion panels for brainstorming and feedback. In these panels, representatives from all sides of the project should participate, for a more objective overview of the situation. This might be useful as a final stage, for verification of the User Needs as they were described by some other technique.

After some co-ordination among the partners of the TRENDS project, some common points emerged from the methodologies for the specification of the User Needs per participating country. These common points were agreed to form the following widely accepted methodology:

1. Interviewing of a number of representatives or key persons of the target groups and experts per country, for a first impression before constructing the custom designed questionnaires.
2. Construction of workshops of key persons for discussion on topics related to the strategic plan of the project.
3. Construction (according to the information provided by the steps 1,2 of questionnaires, and distribution to the potential end users (teachers of schools). These users were categorised in two major groups:
   - Users with experience in using ICT for educational purposes from a limited number of schools
   - Users with no experience in the use of ICT.

4. Presentation of Results

The survey that took place during the TRENDS project, aims to provide the project with clear ideas for the skills/expertise the teachers must acquire through accessing the foreseen TRENDS distance training services. The outcome of this survey will safely lead to the determination of the "Functional Specifications of the Network".

According to the adopted methodology, a number of workshops/round table discussions and interviews were organised firstly, in order to have a starting point and a global view of the user needs, before constructing the questionnaires that were eventually distributed to the potential end-users of the project. In some countries two kinds of questionnaires were distributed, one for the experienced and one for the inexperienced users [TRENDS, Bouras et al. 96].

The kind of participants in the workshops/round table discussions and the interviews, differed among the national sites. Among the participants were, university professors, key persons in education policy making, national experts in ICT and Open Distance Learning (ODL), teachers experienced in the use of Telematics in secondary education, etc. In some national sites a common questionnaire was used for the interviews.

The participants of the workshops/round tables focused on key issues related to the teachers' job profile, his/her initial and in-service training, the "new role" of the teacher implied by the introduction of the new technologies, the needs for support, and the access, cost, management and suitability of the new technologies. The results extracted from the interviews, concern educational policies, the content, forms and aims of further training, and the functional scheme of distance teachers' training on the use of new technologies.

It was concluded that in order to create better conditions to promote the involvement of the educators in TRENDS, it is important to:

- give to the schools better conditions for the kind of activities involved in TRENDS (provision of appropriate classrooms, access to Internet, etc).
- motivate the school teachers (ie. by providing courses focusing on their own interests)
- create or adopt interfaces and user-friendly services
- create a group of users specially prepared to promote the use of the telecommunications services.

In order to satisfy the training needs indicated by the teachers, it was suggested that it is important to develop courses or other initiatives that focus on the following aspects:

- educational methodologies for specific subject areas
- pedagogical issues
- management and implementation of educational projects
- application of information and communication technologies
- integration of information and communication technologies into the curriculum
- provision of essential know-how on using basic telecommunication services such as e-mail, news, fora, bulletin board systems
- development of basic skills on the use of co-operation tools over network infrastructure
- development of basic skills on constructing WWW pages (eg. HTML editors)
- educational potential created by the use of telematics services, either privately or in the classroom

In order to upgrade the educational system, the need for further education and the utilisation of new technologies should be highlighted. Moreover, the teachers should become more acquainted in researching methods and not only skilled in using learning technologies in order to bridge the gap between the degree of technological complexity and the real didactic innovation. The most appropriate way to accomplish this is via small groups or on an individual basis.

Educators should also learn to familiarise themselves with the new educational methods. Different forms of training should applied and co-exist, eg. seminar type, distance training, schools-based, at home. The majority of teachers believe that long distance training should be accompanied by some form of interpersonal communication and contact with other teachers. The vast majority of teachers said they prefer the combination of training with the use of computers and the distribution of related literature.

The experienced users said that their current personal usage of ICT was high, indicating that they used ICT to produce learning resources and for administrative purposes. This usage is less concerning the use of ICT in their lessons. At school the greatest use was in a departmental room, spreaded throughout the day.

Training at school should provide the student with the opportunity to "construct" the new knowledge within an appropriate technological and learning environment. The contact between the trainer and the trainee should make use of all the capabilities offered by modern technology. Another important issue is the development of courses aiming to help teachers to cater for those students whose performances are not satisfactory.

While there is a prevailing use of off-line technologies, the demand is oriented toward on/off-line technology (in the educational and teacher training environments). Among the on-line technologies the prevailing interest is for E-mail and WWW servers, while among the off-line options the prevailing interest is for teaching software and applications. Nearly all teachers would like to collaborate with colleagues from other countries and receive information on European educational programs, mostly for aspects related to the subject taught.

The general attitude of the inexperienced users towards the use of new technologies is quite positive. Most of them said that are particularly interested in initiatives regarding modalities of using new audio-visual and multimedia learning tools. Most teachers prefer to be trained through examples of real applications, or through a combination of theoretical presentations, empirical applications and suggestions on existing literature on the subject. Also, the interviewees seem to be particularly interested in the professional updating of teachers and in the Consultation of encyclopaedia, atlas, dictionaries, reference books.

5. Comparative Analysis of Results

5.1 Introduction of ICT to the Educational Process

First of all, with their all-encompassing approach regarding the specific needs of educators, the countries participating in the project illustrate the principle that training in the use of information technology is not the project's main purpose. The main aim is the familiarisation of educators with the use of ICT as a supporting tool for the educational process. Within the same context is the realisation that the further education of teachers in the field of ICT will improve their professional skills, change their teaching habits and give them a more positive profile which will contribute to the improvement of the quality and efficiency of their work.

Since the educational background of teachers in the use of the new technologies is deemed inadequate, it is necessary that they undergo an initial basic training course on ICT and its capabilities as a teaching tool. In most countries - Spain, Portugal, Greece, France - these needs revolve around certain facets of ICT.

5.2 Application of ICT to Didactics

Nearly all countries have exhibited the need for additional scientific knowledge pertaining to particular subject matter. This knowledge ought to either fill in ascertained gaps in the initial training of educators or contribute to the updating of the educators on the subjects they teach (Italy, Portugal, Spain).

Certain countries (Italy and Portugal) have proposed the introduction of parallel training programs for the interdisciplinary approach to the lesson being taught. The aim is to diffuse knowledge among the users of the TRENDS network. For this purpose, the training model must be as open as possible and satisfy wider pedagogical, scientific and social needs. Within the same framework are:

- The need for further updating of educators on the new didactic methodologies that are developed and applied to each subject matter, is deemed imperative.
- The need to learn ways and methods in order to readjust the didactic methodology used by educators in the wake of the new knowledge they will have acquired and the new skills derived from the use of new applications within the context of ICT (England).
- The need for the provision of additional knowledge regarding pedagogical theories that can be applied in real everyday school situations (Portugal).
- The need to update and educate the students in the new evaluation methods (Greece).

5.3 Needs of End Users for the adopted Training Model

The development of an environment favourable to communication with a content which is of interest to the educator who uses the services offered to the TRENDS users, has been deemed necessary for educators. This conclusion has emerged from the research carried out in many countries (Portugal, Spain, Italy, France). Educators need to communicate on matters regarding: 1) information about the innovations in education, and exchange of information between the users of the system, and 2) update on the organisation and application of educational procedures aiming at the dissemination of better teaching attitudes.

It has emerged from the research carried out in Greece that there is a need for the provision of information on the organisation and functioning of other education systems. The capability to exchange educational material and experiences on the use of ICT is also required. The proposal that students should also be given access to this information is noteworthy. The establishment of these terms of communication will promote, among other things, a European dimension in education (Italy, Spain).

In certain countries educators prefer to be trained within the framework of the school system rather than through on-line communication with the trainer (Spain, Italy). Yet, on-line communication with the instructor (and with colleagues on a national and international level) is generally viewed as a necessary prerequisite. The occasional direct communication between the educator and the trainer is equally important.

Several countries (eg. Italy, Spain), lay stress in the participation of the entire school community (students, teachers etc.) in the TRENDS network. Other countries (Greece) favour both the individual and the group procedure. It has been proposed that groups should comprise people sharing common interests. According to conclusions made in Italy, educators with a different background can only be grouped together, if the sole purpose is to learn the general uses of technology as opposed to using it as a teaching aid for specific lessons.

In several countries (eg. England, France, Portugal) it is generally believed that the educators undergoing further training, who will in turn train their colleagues, that they should have some form of knowledge and experience on ICT, good relations with their colleagues, a positive attitude to ICT and strong motivation.

As for Italy, experts and those from the target group, who are experienced in the use of ICT, prefer to be linked up from their homes. Others, less experienced in the use of ICT have expressed an interest in working both from home and school on the basis of a flexible time schedule.

The provision of sufficient incentives for educators participating in the TRENDS project constitutes one of the more critical aspects for its success. One category of incentives referred to by educators and experts of all participating countries concerns the provision of substantial help to educators to carry out their work. It also entails the opportunity to work with colleagues and students beyond the confines of regional limitations, and access to information sources, the opportunity to develop common projects and initiatives with other educators and bodies outside the field of education. Finally, educators must be able to take advantage of the benefits provided by long distance training (flexibility, speed) and fulfill their professional ambitions.

6. Conclusions

The synthesis which has been attempted in order to illustrate the basic common needs of educators in the TRENDS project, led to the following conclusions:

- The use of ICT in the teaching process seems to be promising and beneficial.
- The programme should not only furnish supplementary knowledge on the subject taught, but also provide guidelines for interdisciplinary approaches on common matters.
- Information should be provided on the use and opportunities provided by access to educational material databases, documentation centres, electronic libraries etc.
- ODL is a method accepted by the majority of the members of the target-groups in each country.
- On-line communication between the educators and their trainers and colleagues is generally viewed as an elementary tool and essential precondition.
- The combination of vision, text, sound, video etc. is generally considered necessary, as is the use of WWW server, e-mail, news, video-conferencing etc., along with some relative printed literature.
- The TRENDS network would rather use existing communication technologies (eg. Internet, Euro-ISDN).
- Schools are generally accepted as the training grounds, provided that some infrastructure problems are solved. Many educators however have expressed the interest to undergo, when feasible, training at home.
- As for some incentives to participate in the programme, it is advisable, apart from strictly educational considerations, to examine others such as training certification, accommodations with respect to the work schedule at school, financial benefits, etc.

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Hermes Service: Distributed Hypermedia Educational Services on Demand

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Abstract: In this paper we present a distributed HypERMEdia SERVICE (HERMES SERVICE) which supports integrated capabilities for distance education and learning purposes. Hermes service consists of hermes servers and hermes browsers. The users are connected with the service using hermes browsers and retrieve hypermedia lessons organised in thematical units. The lessons are stored in various distributed Hermes servers which retrieve the requested lesson and transmit it to the corresponding browser on on-demand basis. The requested lesson is presented to the user according to a well defined presentation scenario. The media objects are rendered in a synchronized manner according to the spatio-temporal relationships existing among them. Finally, special monitoring mechanism controls the state of the network and adjusts the presentation process so as to improve presentation quality.

1. Introduction

During this last decade we have experienced a new trend towards teletraining. The need for teletraining systems has been mentioned from the early eighties, but with the advent of this decade, the evolution of multimedia technology in conjunction with the new perspectives that the networking technology has brought, provided new potentials for the development of teletraining systems.

This new challenge will play a significant role in the near future, as it will be possible to access education, training and retraining whenever and from wherever required by the learners. This novel way of training motivated us to design and implement this distance education service. The scope of the service is to provide to the user a set of functionalities for retrieval and browsing of lessons which are stored in various distributed servers.

Our proposed service provides a number of advantages which can be summarised in the following points :

- *transparency*: the user focuses on the service and the provided lessons, while internal information regarding the distributed organisation of the service and the interconnection of the various computer systems over the network are hidden
- *ease of use*: an integrated and friendly graphical environment, implemented in various platforms, provides the user the necessary capabilities to interact with the service
- *on-demand delivery*: the requested hypermedia lessons are transmitted on on-demand basis and not on store-and-forward mode, and as a result good performance is achieved, while the needed resources are reduced [C.Bouras et al. 1996b]
- *resource management*: special monitoring mechanisms are included in the service in order to detect network bottlenecks and presentation anomalies. Using these mechanisms the needed resources are dynamically reserved [C.Bouras et al. 1996b]
- *integrated presentation environment*: the presentation of hypermedia documents is done in a well structured environment without the external invocation of presentation "players" [R.Steinmetz 1990]
- *search capabilities*: the user may search for topics of interest and retrieve the matched items avoiding the selection of a particular lesson
- *subscription-authorisation mechanisms*: the user must be member of the service in order to have access on it. Therefore, non-authorized users are not permitted to use the service
- *compatibility with the WWW and e-mail facilities*: the user may also browse html documents, send and receive e-mails. This capability is considered useful in order to communicate with the constructor of each lesson and ask additional information on themes of interest
- *flexible and modular design*: the design of the service is performed having in mind the embodiment of new functionalities and the provisioning of variety of media formats. The followed design approach is the object-oriented.

2. Architecture Overview

The architecture of Hermes service is based on the client-server model. The basic components that comprise it are the following ones:

- *Hermes server* where the lessons are stored. For every lesson a presentation scenario is associated. The presentation scenario of a lesson actually describes the spatio-temporal relationships among various media objects. The inline media objects are stored in the corresponding media servers. When a request for a specific lesson is triggered, the specific server where that lesson resides on, is contacted. The server searches the database of provided lessons and locates the requested lesson. When the presentation scenario is found, Hermes server activates the involved media servers in order to start the transmission of the corresponding media objects which are referred to the presentation scenario on on-demand basis.
- *Media servers* in which media objects are stored. For every media object (e.g., text, image, audio, video, etc) a media server is associated with each Hermes server. These media servers may be located in the same host with the Hermes server and each one is responsible for transmitting a certain media type through a parallel connection which is established between the browser and the corresponding media server. The involved media objects are transmitted from the media servers towards the browser according to the presentation scenario and the presentation constraints. The transmission process of each media object is adjusted according to the feedback reports which are sent by the Hermes browsers and describe the status of the network and the presentation process.
- *Hermes Browser* is the integrated graphical environment through which the user interacts with the service by retrieving and browsing lessons. The browsers may run on a multimedia PC and facilitate all the provided functionalities of the service. The browsers also manage the synchronized presentation of the requested hypermedia lesson. Internal mechanisms monitor the status of the network and report the network and synchronization anomalies to the corresponding Hermes server and media servers in order to adapt the transmission rates. In that way, the presentation quality is significantly improved while the needed resources are dynamically reserved.

3. Functional Description

Since Hermes is a service designed to be used from users, we focused on *simplicity* and *functionality*. In the sequel, the basic features that make Hermes Service a useful and attractive service for educational purposes are introduced.

- Connection-Subscription with the service
- Search for related topics
- Viewing a lesson
- Off-line interaction between the tutor and the users

3.1 Connection-Subscription with a Hermes Server

The connection primitive is the first action that the user must follow in order to access the service. Initially, the user must specify the Hermes server that desires to connect to. For that reason, a list of available Hermes servers is provided. For every Hermes server, a small description concerning the kind of lessons that are stored in it, is presented. Every Hermes server contains lessons concerning specific and well known thematical units. Therefore, the user may easily access the server of his preference. When the user specifies the Hermes server that desires to connect to, an authentication process takes place in order to verify whether the specific user is authorised to use or not the service. If the user is not an authorized one, he is requested to subscribe to the service filling a subscription form as it is depicted in Figure 1. The subscription form contains various information, such as the real name, the address, the postal and e-mail address and telephone number of the user. A coherent, centralized database of authorized users is updated, and from now on the user may easily access the service. Whenever a user is connected with the service, the database of the authorized users is updated and specific information about the exact time logged in the service, as well as, the lessons that are retrieved are captured.

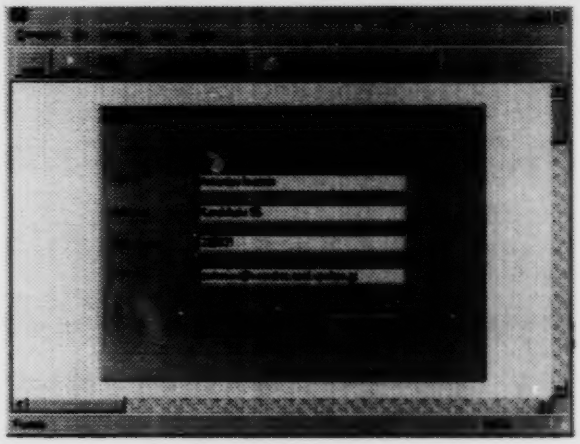

Figure 1: The Subscription Dialog Box

3.2 Search for Related Topics

In case the user is interested in a certain topic, he is able to search the contents of the *whole* service by invoking the search primitive. In particular, the user specifies the search token which best describes the topic of interest, and selects the server that is likely to contain lessons on the topic. The user selections are transmitted to the specified server and in the sequel, all the text documents stored in that server are scanned. Additionally, this particular server sends the query to all other Hermes servers for the same reason. In every server the same procedure is performed. The results of the query on every

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server are forward to the initial server and then directly to the user. It must be noticed that only the lessons which contain the item of interest and the server location are transmitted and presented to the user. In that way, the user may search the contents of the service and retrieve only specific lessons on particular topics, avoiding the navigation through all the provided lessons. In addition to that, the user using a friendly dialog box, as shown in the following Figure 2, can specify the search options.

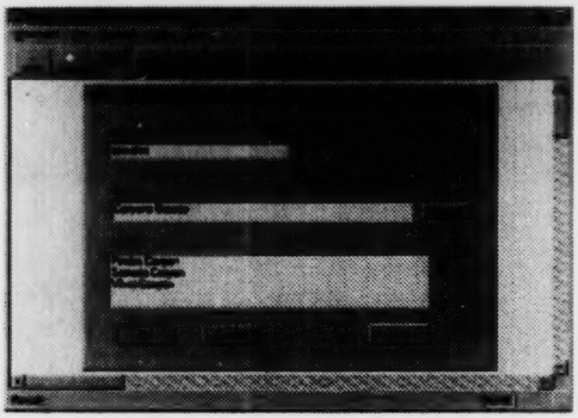

Figure 2: The Search Dialog Box

3.3 Viewing a Lesson

After the connection has been established, a list of available lessons which are stored on that server are presented to the user. The user may select a specific lesson from the list by "clicking" on the corresponding hyperlink. In that case, the request is forwarded to the server. The server upon request retrieves the presentation scenario of the lesson and determines the inline media objects as well as the spatio-temporal relationships among them. For every media object referred in the presentation scenario, the server determines the media server at which it is stored, and specifies the transmission requirements for that object. Consequently, all the associated media servers are contacted and the transmission requirements for every media object are explicitly determined. Every media server, builds a parallel connection with the browser, retrieves the media object, transmits the data on on-demand basis based on the transmission requirements. During the transmission of the media objects feedback reports are sent to the involved media servers and the Hermes server in order to adjust the transmission rates or the enconding format.

At the browser site, the presentation scenario of the requested lesson, which is sent by the Hermes server, is scanned and the needed resources are reserved. Every media object is temporarily stored inside the buffers, and then is presented to the user according to the presentation scenario [Chun-Chuan Yang and Jay-Hsiung Huang 1996], [Herng-Yow Chen and Ja-Ling Wu 1996]. The browser during the transmission of the hypermedia lesson, collects information about the network status and the presentation quality, i.e. the presentation anomalies that may occur.

From the application point of view, the user may follow sequential or explorational links. The sequential links specify a coherent view of the lesson, i.e. the tutor's way, while the explorational links are relative to theme hypermedia documents with additional information on specific topics. In both cases, the browser manages the user selections in the same way. If the selected lesson or topic is stored on another server, a suspend connection primitive is invoked, and a request for a new connection with the new server is triggered. The suspended connection remains active for a period of time in case that the user requests to view a previously selected document. When this interval is passed, the connection closes and the attached client is informed about the event. At that time the client has an active connection with the new server. At any time the user may disconnect from the service by "clicking" on the appropriate button.

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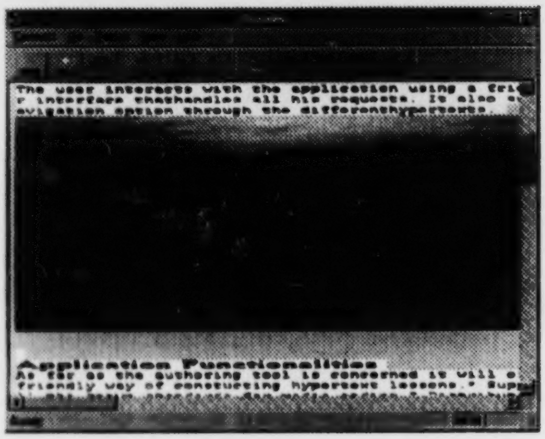

The user interacts with the application using a fri
r interface thathandles all his requests. It also
avigation option through the differenthypertexts.

Application Functionalities

As far as the authoring tool is concerned it will
friendly way of constructing hypertext lessons." Sup

Figure 3: The Browsing of a Lesson

Among the several facilities that can be supported by the browser are the following ones:

- Moving *back* and *forward* in the list of already viewed lessons. This can be achieved with the use of menu buttons.
- *Scrolling* of the hypertext document.
- *On-line help* provision.
- *Interactive* operations can be triggered during the presentation of the lesson. The user can pause the presentation of the lesson and resume later from the point that it was paused via control buttons.

In

Figure 3, an example of the browsing process is given.

3.4 Off-lineInteraction Between the Tutor and the Users

In case the user wishes to make comments or submit questions concerning a lesson, he is able to use the e-mail service offered by Hermes. The user can send e-mail to the tutor asking for additional information about a theme. In that case, the tutor can send replies to the user prompting him/her to retrieve specific lessons from the service. Using this off-line mechanism an immediate connection between the user and the tutor is achieved and as a consequence, the educational activity is improved. Therefore, the user may avoid the useless navigation through relative but not specific lessons of interest.

4. Implementation Issues

The Hermes server has been developed under the Unix operating system using the facilities offered by OSF/Motif, Xtoolkit and Xlib. On the other hand, the Hermes browser has been implemented both under the Windows 95 operating system using Visual C++ version 4.0 and the Unix using OSF/Motif. The implementation of the network support primitives that are needed for the realisation of the on-line operation is based on the TCP\IP protocol suite. The hypermedia presentation scenario is transmitted through TCP connections, the non time sensitive media objects (e.g., text, images, graphics) are sent under TCP connections, and the time sensitive media objects (e.g. audio, video) under UDP connections. We utilize the UDP connections for the time sensitive data in order to avoid the additional delays introduced by re-transmissions. Although the UDP is not a reliable protocol, it seems that adequately meet the requirements for real-time sensitive data. In addition to that, the network connections for the control data are transmitted through TCP connections. The underline network infrastructure is an 100 Mbit/s FDDI ring which is able to support on-demand service. Despite the fact that our service does not based on quality of service guaranteed networks, the adaptive nature of the

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service in conjunction with the network monitoring facilities may significantly improve the presentation quality.

Furthermore, we used the Real-Time Protocol -RTP- [H.Schulzrinne 1995] as a transport vehicle suitable for transmitting time sensitive data. The RTP\RTCP resides between the transport and the application layer and are designed to be independent of the underlying transport and network layer. We used the RTCP protocol for the transmission of the control data, and the RTP protocol for the transmission of the presentation scenario and the inline media objects. The RTP protocol provides end-to-end delivery services which include payload type identification, sequence numbering, timestamping and delivery monitoring. The RTP itself does not provide any mechanism to ensure timely delivery or other quality-of-service guarantees, but relies on lower-layer services to do so. The RTP control protocol (RTCP) is used to transfer feedback monitoring reports concerning the network status and the presentation anomalies.

For the description of hypermedia lessons we implement a hypermedia, html-like markup language with simple synchronization primitives. Using that language the tutor can explicitly specify the layout of the hypermedia lesson and the spatio relations between media objects. In particular, special keywords for the text formation, the figure and graphics placement are provided. In addition to that, the constructor of the lessons may also specify the temporal relations among the inline media objects, like annotated text.

The system has been installed and successfully tested on a variety of SUN SPARCstations and PCs with different memory and processing power characteristics. The system can efficiently operate over LAN and WAN networks.

5. Conclusions and Future Work

Hermes service can support the distance education process bridging the gap that is created by the geographical distances that separate users from tutors. Its real-time characteristics along with the attractive user-interface make it a useful service for realising the purpose of distance learning.

Hermes service provides an integrated graphical environment for the synchronised presentation of hypermedia lessons which are stored in distributed Hermes servers. Additionally, the included searching capabilities and e-mail facilities constitute our service an integrated educational environment which helps the user to acquire the topics of interest with a friendly and transparent way. Finally, Hermes browsers can present html documents, and as a result compatibility with the WWW is achieved.

In the future, we intend to incorporate special mechanisms for efficient information retrieval, to support the presentation of MHEG hypermedia-like documents, and to implement network interfaces for quality of service guaranteed networks like the ATM.

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TELEMATICS AND VIDEOCONFERENCING FOR TEACHING AND LEARNING

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ABSTRACT:

This paper describes developments looking at the application of technology and telecommunications in rural government secondary schools in Victoria, Australia Schools involved in the projects are at least 150 kilometres from Melbourne, the capital of the State, with most of them being more than 300 kilometres distant. These schools deal daily with the tyranny of geographical distance and the associated difficulties of endeavouring to offer a wide selection of curriculum to their students. The issues rural schools face generate some innovative methods for connecting teachers and students in curriculum delivery and in the exploration of alternatives approaches to teaching and learning.

The presentation will briefly detail some of the experiences of the clusters of schools adopting technology approaches to curriculum delivery; the management structures adopted; the attributes of co-operation and collaboration which characterise their work in the joint delivery of curriculum; the technology facilities available to schools; the curriculum subjects on offer and strategies used by teachers in adopting alternative approaches to teaching, learning and curriculum delivery. Finally the paper will briefly discuss training for teachers, evaluation to date and future plans.

Introduction

The use of electronic technologies in facilitating rural education is not new in Victoria. Seventyfive schools in isolated areas of the State have been working in clusters or groups of schools for over ten year (Marghitta, 1989, Conboy, 1989) to deliver curriculum by electronic means. Until recently the predominant technologies have been audio (phone conferencing) or Telematics/audiographics (MacFax-Duct; Electronic Classroom software (Elliott,1992). However more recently many schools are integrating facilities offered by the Internet and in 1996, twenty seven schools acquired full videoconferencing facilities, which are currently being implemented in various configurations.

A Little Bit of History: The Original System

Victoria is a southern State of Australia with 780,000 primary and secondary students in 2,300 schools. The State has a dual system of State and private education. The State system caters for 528,000 students with 1340 primary schools and 400 secondary schools. State and prhate schools cater to the needs of both metropolitan and rural communities.

In 1983 an Australian government report, known as the Burdekin Report, into school retention rates in senior years found that students in rural schools were less likely to remain at school for the final two years of secondary education. The major reasons for this were identified as the lack of choice of subjects in the curriculum and a shortage of specialist subject teachers in country schools, especially in the Science & Technology and Languages other than English (LOTE) areas. One solution to this problem was explored in the trialing of electronic telecommunications in remote schools to share teacher expertise across clusters of schools, thus widening the subject choice for students in these rural schools (Conboy, 1992).

Teachers worked on an 'extended classroom' model of communications and delivery, an early 'open learning' model in which the 'walls' of the classroom were viewed as the boundaries of learning. The same methodologies and approaches to teaching and learning as were used in the classroom, it was assumed, could be applied in asynchronous communication in distant environments with the assistance of appropriate technologies. The technologies were again identified within the framework of the group-based teaching approaches of the traditional classrooms.

'Telematics' was the term used originally to describe the application of electronic telecommunication for distance education in Victoria. Whilst later deHmitions (e.g. Hill, Meulenberg, McNamara &: De Wildt, 1991) have turned more towards the 'human' focus of the concept, the original definition in the Australian context referred mainly to the system configuration which consisted of an electronic blackboard (a Macintosh computer, using specifically developed 'blackboard' software -'Electronic Classroom') (Crago, 1992), linked using a PSTN telephone line via a modem to a computer/modem at the remote site. The classroom 'voice' link was provided through a second phone line fitted with a loudspeaker phone system. The 'paper' or notes link was provided by a fax machine, which in most schools 'shared' a phone line in the school office, or alternated with the 'blackboard' link. Whilst other more integrated systems, such as the IBM based OPTEL system were also considered, in the Australian context these were cost prohibitive. Many schools today continue to use the audiographic system as their primary distance delivery mechanism, with recurrent costs met through a central Department fund. Associated with this original project were a number of management, professional development and teaching and learning considerations which continue to inform current projects and practices as we learn more about the needs of remote learners and as technological capabilities continue to expand.

The Organisation: Clusters

Originally groups of schools in the same or close geographical proximity were grouped together. These groups - or clusters - are now an integral management component of technology-based teaching and learning developments and meet on a regular basis to share planning days and work on collaborative projects. In 1997 there are 19 clusters supporting 84 schools with, 675 students taught by 52 teachers in 61 subjects.

The schools are responsible for the design and delivery of the curriculum material and resources students use in their courses, with the central or State administration funding the initiatives. This emphasis on Statewide coordination has led to considerable cost benefits through centrally coordinated sharing and development of expertise within the clusters. For example, the implementation of technology has been on a Statewide basis with all schools having a similar configuration, thus avoiding many of the issues of non-standardisation. Some would argue, and rightly so, that there are some compromises with standardisation, such as limitations of the creativity which often characterise projects with a larger degree of freedom. However, paralleling the broader implementation of the standard formats and systems has been ongoing exploration and research into the newer technologies and alternate approaches and environments, in various parts of the State.

The Technologies

A consequence of technological development and ongoing research, original technology configurations continue to be upgraded, replaced andlor supplemented by peripherals such as scanners, digital cameras, CD ROMs, sound and video cards and cameras and videoconferencing. Hand-in-hand with these improvements to Telematics have been software improvements to 'Electronic Classroom' especially designed for use in the Victorian system (Ellis, A., Debreceny, R., Crago, R., 1996). 'Electronic Classroom' is the software used for Telematics, an Australian program developed by a programmer to suit the needs of Victorian teachers and students, written specifically for Macintosh computers. It allows computers at several locations to communicate with each other as a substitute blackboard.

With the world wide focus on exploration of the potential of the Internet and its resources for teaching and learning in the global environment, Victorian schools too have been and are becoming more deeply involved in exploration of this tool. As an example, in 1995 a group of Telematics schools teaching German trialed the use of the Internet as a teaching and learning tool. These teachers and students found many advantages in using email and Internet. Teachers reported improved learning outcomes for LOTE students - one of the outcomes they experienced was that the learning was set in a more realistic setting with a real reason for communicating in the target language. Usmg email students and teachers reported greater access to their peers in remote locations. All students said they had improved their skills in Information Technology and Telecommunications. Some teachers and students searched the Internet looking for links to German sites and making cultural connections for project-based work requirements.

Another advance in technology has pointed the way for schools to use even more advanced technology for teaching and learning. This further step was facilitated with the recent introduction of digital telephone services in rural Victoria, and the way was opened for school trials with videoconferencing over ISDN lines.

Teaching Strategies and Professional Development

Whilst the various dimensions of teaching and learning with technology continue to expand our knowledge and understanding of the differences and similarities in human requirements and needs in learning 'beyond the physical classroom' there is also a real need to disseminate and share the experiences of those involved in these explorations and developments (Dwyer, 1994). Thus the forms of organisational management and professional development form an integral component of project development.

At the cluster level, teachers in clusters work as a team, supporting each other with ideas and strategies which work for them within their cluster culture, encouraging each other at group days and professional development days in the cluster.

Example of professional development for teachers using telecommunications technology

On a State level, each year a Statewide training conference is held at which teachers display their experiences as team leaders and activity facilitators, passing on to others new to the approaches, strategies for best practice, and experiencing hands on practice with the technology and contact with peers which lead to networks of teachers supporting each other. New technology and new ideas in the field are presented in a cooperative informal atmosphere and valuable networking has resulted which is continued throughout the year and across cluster boundaries (Cerbasi, 1997). URL http://www.wimmera.net.au/edenhope/Telematics/Debit.html

One of the growing areas of need in professional development and on-going sharing relates to the Internet. Although it continues to be an increasing force in the educational life of students and teachers, ideas on how to use this electronic tool need to be exchanged and built on by all teachers. The mechanisms of cluster organisation and accompanying state professional development support these endeavours.

Schools have begun to use discussion groups for remote or electronic conferencing and gradually, as more schools access the Internet and the per hour cost of access to the Internet decreases, teachers are seeing the benefits of using the Internet and telecommunications generally as a teaching and learning tool. The impetus for change thus continues to progress exponentially.

As technological developments are realized there seems to be a natural trend for teachers experienced in Telematics and distance teaching to encompass the new developments with more ease than their classroom based counterparts (Marghitta 1994). Similarly, it might be suggested that teachers with such experience in their professional skills are demonstrating a more discerning approach to the characteristics of the newer technologies and a richer understanding of the fundamental changes taking place in the nature of teaching and learning with, and through, technology. Many teachers who have taught remotely, using Telematics are appreciating the capacity to *see* their students with full videoconferencing and have reported that this sophisticated, yet in many ways simple, development has facilitated a greater 'esprit de corps' in the class than was possible with the less holistically visually oriented audiographics system. On a contrasting note however, some have proposed a question for exploration in noting that the 'video component can, at times detract from the task at hand' - and this may be related to subject, discipline and individual taste. One teacher of English Literature said it was quite important to be able to see all participants in discussions and made sure that the cameras were positioned so that the students were visible.

Even with the more holistic views of videoconferencing however, experienced teachers continue to report the need for different types of interaction, ranging from face to face to the use of full video and simple audio (Daunt,1994). Particular days have been planned by schools and clusters, in which all students meet face-to-face, travelling the eighty kilometres in order to get to know each other better, before classes commence, or in the early days of courses.

It is not only the teachers who are mindful of the need for different 'human' approaches too. Many classes have adopted a procedure whereby a few minutes is devoted to social discussion and chit-chat at the beginning of each on-line session, regardless of the technology (ie both with audiographics and videoconferencing). These strategies have been used by Telematics teachers for a number of years as an important part of the socialising of the distance education class and to allow the teacher to get to know his or her students. Building personal relationships using technology is like creating a virtual classroom.

Towards a more holistic approach.

Until 1995 audiographics/Telematics was the predominant electronic means for teaching students in these remote schools. The Department of Education commenced trials of desktop videoconferencing in clusters when this technology became economically and technically viable. In 1995 the first cluster of schools was provided with videoconferencing facilities to trial distance teaching for delivery of curriculum. The introduction of videoconferencing was dependent on rural schools being able to receive digital telephone services - ISDN capacity being available in only some country areas. One of our major telecommunications providers, Telstra, is ensuring that all country exchanges in Victoria have this capacity to service country districts.

Videoconferencing: a Case for the present: a Case for the future.

Videoconferencing is currently being used on several levels throughout the state. The trialing of videoconferencing had several aims. In summary it aimed to explore the possible applications of the technology to assist in:

- enhancing curriculum delivery and student access to a comprehensive curriculum across the State
- sharing particular curriculum between sites - along the lines of master lessons/discussions/ lectures -for example between Science & Technology Centres Tertiary/ industry presenters and target schools.
- sharing access to visiting presenters, both for administration and curriculum.
- sharing special programs eg, Gifted children, disadvantaged students
- trialing links with Technical and Further Education Institutions (TAFE) for access to dual recognition programs
- trialing links with institutes of higher education and universities for professional development and delivery of accredited courses
- linking geographically dispersed teacher network members
- linking Victorian administrative networks in regions - School Principals, Working Parties
- trialing links with the Department's headquarters in the centre of Melbourne (the capital city of Victoria)
- linking sites for teacher professional development (EkinSmyth, 1995)

Let me now briefly provide a context for the aims of the trials by explaining a little about the focus and structure of technology related developments within the Victorian Department of School Education. The Department of Education has a particular division, Learning Technology Projects, whose brief it is to initiate, develop and manage technology-based projects across the schools sector within the state.

The division is responsible for overseeing projects such as the Telematics Project (Arms 1996), the exploration of the Internet and for videoconferencing, an interactive satellite network and a group of model schools called Navigator Schools, URL http://www.dse.vic.gov.au/navigato.htm.

A group of Secondary Schools has been designated as Science & Technology Centres. URL http//wwwdse.vic.gov.au/stcdesc.htm. Their mandate is to promote the teaching and learning of Science and Technology in schools Statewide.

Teaching and learning using technology is also the focus of the seven Navigator Schools. They have been set up to model exemplary teaching and learning and provide models for practicing teachers. Teachers and principals can participate in practicums and seminars where they attend sessions teaching them to plan and manage technology needs in their schools. Other sessions use counterpart training and workshadowing whereby participants work with Navigator School teachers on a 1:1 basis.

Videoconferencing then is one of many initiatives which the Department of Education promotes as part of its School Programs Division. Videoconferencing can be integrated into SOFNet - the Statewide interactive satellite network, also maintained by Learning Technology Projects. All schools in the state have been provided with satellite receiving equipment - for curriculum delivery and training for teachers through programs which are transmitted from studios in Melbourne.

SOFWeb is the Department of Education's Home Page on the Internet. This site is an extensive educational resource pointing to useful information for teachers and students. It promotes collaborative learning in such projects as the Global Classroom Project, (Coppinger&Hocking, 1995) I* EARN-a showcase for student's work, listing home pages for Victorian Schools on the Web, amassing case studies of leading practice in the use of Learning Technologies indexed to Key Learning Areas, reviews and research of Learning Technologies, and is a site where many Department of Education policy documents, guides and tender information is found. Discussion groups and conferences are being developed, the Virtual Lounge, Parents in Cyberspace and many other features and links to the Internet are accessed through this page. URL http://www.dse.vic.gov.au

In the not-to-distant future interoperablility of videoconferencing (especially desktop videoconferencing) and the Internet is envisaged, however currently it remains an issue to be resolved. As this technology is refined and simplified and becomes cheaper more schools will be able to afford videoconferencing as a part of their entry to the Internet. Multipointing - connecting more than two sites - is expensive at this stage, but it is anticipated that this too will become more affordable as more schools take up desktop videoconferencing.

Some preliminary data and findings.

A year into the trials it has been possible to witness the development of a number of levels of consideration.

There now exists a pool of teachers who have begun to develop their own strategies to address the teaching and learning needs of this environment. On a more practical level, some teachers focused on the physical characteristics of the teaching spaces, such as making a study of how everyone set up their room, light sources, location of table and chairs, some became aware of the need for choosing clothes and graphics to best highlight the light, colour and transmission possibilities to make the images more meaningful to the viewers.

Others focused on the use they made of the medium as a means of networking with colleagues in their field of interest within the cluster of schools and the ease with which they could contact experts in their field.

Of course, others focused more directly on the cognitive and social demands of teaching via the mechanism. As much of the trialing to date has focused on Year 12 - the final year of Secondary education in Victoria - teachers worked closely with their students in discovering

- how they were acclimatising to videoconferencing,
- how they used all the features of the technology,
- how the administrative back up worked in each of the schools in which their students were situated,
- how well their students coped with learning in this mode - which reflected in their examination results

Perhaps a few vignettes and anecdotal observations from the teachers will serve to demonstrate some of the considerations which are now being generated by this project

A question which is often asked of the teachers is how they can be sure that the work the students presented for marking was really their own work - how could the teacher authenticate each students' work?

> *One teacher noted that for this aspect of the extended classroom to work it is important to get to knowyour students early in the school year so that you know what to expect from them. All work was submitted on-line, so the students were exhibiting their technology skills and having ownership of their contribution. Also, paying visits to the remote students and sometimes actually teachingirom the remote site allowed the teacher to understand the constraints under which the remote students worked Also, students at the teacher's base school were able to appreciate the conditions under which their remote peers learnt.*

Not everyone finds the full videoconferencing facilities appropriate.

> *One teacher who has used an audiographic system since its introduction into the Victorian Education system, found that he and the students were more comfortable using an electronic whiteboard for teaching and learning rather than using collaborative computing via videoconferencing His subject was Accounting and he found that the teacher and students all had greater facility with manipulation of figures this way. The students at each location still saw the students and teacher on the screen but the actual computing was done on the electronic whiteboard. In sessions where there was mainly discussion and collaborative work was being done on assignments or projects, all features of the videoconferencing were used, for instance when a video of the Stock Exchange working was shown.*

Alternately according to an English literature teacher:

> *For Literature discussions you need to see the students all the time . "I use the videoconferencing 100% of my teaching time with these students. "*

Others have expressed similar likes:

> *"I think videoconferencing is far superior to Telematics and the students like learning this way. "*
>
> *"I have used both systems andfound there was greater clarity of picture with the room system and it had more features to offer as a tool. There was a better picture from the students on the desktop system as seen at Wangaratta than at Wodonga The kids f ind it FAR, FAR superior to the old system. It makes them feel part of the class."*

Teacher organisation and management has also drawn comment

> *" Videoconferencing has led to a marked improvement in delivery of curriculum. Students are more enthusiastic and curriculum delivery more efficient. It is good for teacher meetings; saves travel time. "*
>
> *"Professionally an excellent experience."*

And fnally as an example of the activities being undertaken in bringing expertise beyond the school and town into the classroom(s)

> *Students from a secondary school, Manangatang, 450 kms from Melbourne, were able to link into Courtroom 4 of the Melbourne Magistrate's Court to view a mock courtcase and afterwards discuss points of law and general information with all the courtroom personnel.*

> *In another situation, a Year 12 class in the country requested a speaker on one of their VCE English texts. A teacher from Melbourne fulfilled this role, addressing the students on the text, then discussing it with them.*

As a general comment it has been observed that these schools and teachers are developing a wealth of experience in teaching using electronic technology and are using these strategies in videoconferencing for collaborative computing, adding videos, digital images, using snippets from CD ROMS or slides as natural parts of their lessons.

To the Future

Teaching and learning using telecommunications technology in all its diversity is an important part of the future of education. The Internet is being explored by classroom teachers throughout the world as a means of teaching. In a changing world, the learning environment is gradually changing as educators see the enhanced possibilities which telecommunications has to make a quantum leap into the future. It may not be too excessive to claim that the very nature of teaching and learning, and the fundamental assumptions of each, will change drastically in the near future (if not in the already present!). These teachers in Victoria who have the experience of using Telematics and now videoconferencing to teach students in remote locations are well poised to begin adapting their curriculum to this new world where distance is simply a mindset.

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Integration of external WWW-Documents into the Electronic Classroom

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The WWW from the educational point of view

The Internet has experienced a fast growing expansion to an information network, especially after the appearance of the WWW with its interactive graphic interfaces.
Today it is widely used by Internet service providers, diverse commercial and non-commercial services, schools and businesses in education and vocational training, and private users. Although the Internet as well as the WWW were in their beginning mainly used by universities and research institutions, they were originally not designed to support educational use. Their main use is information exchange and retrieval. Though the WWW represents a pool of up-to-date information that one may want to use to prepare presentations and learning material, it is not well equipped for preparing didactically sound material and presentations. In the following we point out some weaknesses of the WWW from the administrative point of view and for didactic criteria:

- Links are not administrated in such a way that links to documents which change their address can be updated automatically.
- Another consequence of the lack of link administration is the impossibility of determining which documents point to a shown document. (This causes specific didactic problems that will be discussed later.)
- There exists no overview of the outgoing links embedded in the document, unless the author specifically creates one with the help of HTML-frames.
- Only text oriented material with few possibilities for graphical interaction is available. Other material is time consuming to develop.
- There is no comfortable way to change material during a lesson.

While there are some genuine solutions for the administration of globally networked hypermedia documents which elimininate some of these deficiencies, most of the documents on the WWW are only available with the limitations already mentioned above [Andrews95] [Duval95].
To solve these problems, we propose that the WWW be integrated into an originally didactically motivated basic representation. This integration causes better management and more flexible preparation. In the following we focus on management. Our application scenario is a computer-integrated classroom based on [Hoppe93]. It has the following features:

- central interactive presentation by means of an electronic blackboard [Stefik87] [Elrod92];
- workstations for students networked among themselves and with the blackboard;
- functions to distribute "electronic worksheets" and other multimedia material;
- interfaces for intelligent monitoring of the student's work (with local feedback as well as feedback to the moderator);
- co-operation on the basis of synchronized applications;

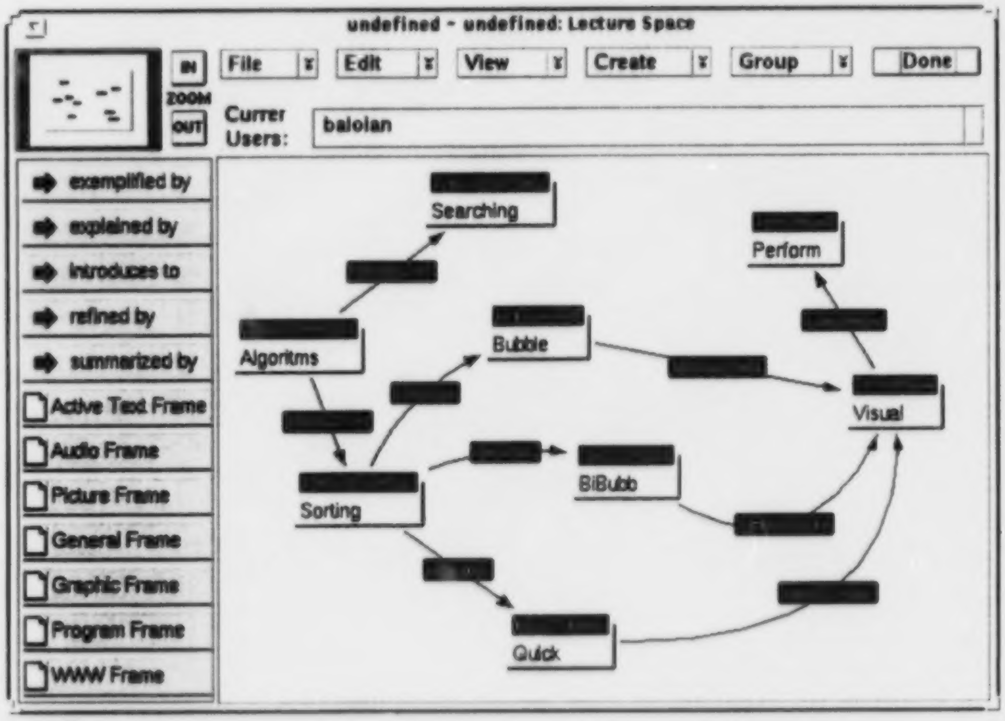
undefined - undefined: Lecture Space
IN
ZOOM
OUT
File
Edit
View
Create
Group
Done
Currer Users:
baloian
exemplified by
explained by
introduces to
refined by
summarized by
Active Text Frame
Audio Frame
Picture Frame
General Frame
Graphic Frame
Program Frame
WWW Frame
Searching
Perform
Algoritms
Bubble
Visual
BiBubb
Sorting
Quick

Abbildung 1: **The authoring environment**
At the left-hand side are the buttons with which the links (arrow symbol) and the nodes (document symbol) can be generated. In the center there is an example of a Didactic Network. In the upper section are the editing helps and in the upper-left corner an overview of the whole graph.

A discussion of the intelligent run-time components can be found in [Hoppe95]. The starting point of the following considerations is a special authoring environment for the computer-integrated classroom. Basically, it supports teacher presentations of multimedia learning material on the electronic blackboard. The approach is to represent the curriculum as a graph with typed links and nodes called Didactic Network. Links represent a transition between presentation frames including certain didactic functions. The nodes contain the presentation frame where the type indicates the associated delivery medium. Compared with WWW-documents, the Didactic Networks produce additional information. This additional information, which offers a better context, includes the node type and the link type of the predecessors and successors. This paper offers a solution for integrating external WWW-documents into Didactic Networks to achieve better management and use of the WWW for didactic purposes. To do this, we have to distinguish the functions of the authoring system and the presentation environment.

Didactic Networks

The authoring environment (figure 1) supports the creation of a lecture concept or curriculum as a Didactic Network.
A Didactic Network is a directed graph. An "entrance node" (or root node) is required which should not be the successor of any other node. The nodes are typed and are coupled to certain methods. The type of node indicates the presentation medium which will be invoked for showing the

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node's information during the authoring and the presentation phase. The following frame types are predefined: ***Active Text Frames, Audio Frames, Picture Frames, Graphic Frames, Program Frames, General Frames***[Baloian95]. Common methods such as ***add content, remove content*** and ***open***, are attached to frames and invoke the corresponding tool.

The links are labelled with didactic functions. There are no restrictions concerning the node types which can be connected. The following set of labelled links are available: ***exemplified by, explained by, introduces to, refined by, summarized by***. These links primarily focus on the didactic cause of a transition between nodes, not on the relation among the nodes' content. They serve as didactic support during the presentation.

The explicit management of links simplifies the determination of the incoming and outgoing links for each node.

The use of a graph as a representation of a curriculum simplifies its modelling because different aspects can be represented simultaneously. Firstly, because the graph defines a causality among units, the sequential structure of the lesson can be automatically derived. Therefore, it is possible to determine at any moment which nodes represent the basis for another one.

Secondly, due to the abstraction of the lesson content through the use of nodes it is possible to have an overview of the curriculum which enables the author to deal with more complex curriculum representations. Such complex curricula can be the result of additions and modifications made during a certain period of time. These complex representations facilitate and make further lessons more flexible because of the number of contained units.

Thirdly, the links labelled with didactic functions can motivate reflections about the adequacy of the structure being constructed and its accommodation to the teaching needs.

For the solution presented here we see following advantages:

- Nodes represent an abstraction of their content with the help of mnemonic naming. This supports the clear representation of the lesson.
- The overview eases the change between material and units even if the connection is transitive over several nodes.
- The nodes are typed according to their content media type and can be used to invoke the appropriate viewer or tools directly. Therefore, they support the presentation phase.
- Links define a partial order among the nodes (predecessor-successor) and, therefore, for the scheduling of the lesson content.
- Because graphs can be traversed in many different ways, there is a flexibility in defining the final shape of the curriculum during the presentation itself.
- The links are labelled. This information can be used for defining the border conditions of the presentation.
- The didactic functions support the reflection of the lecture's concept.

The authoring of a lesson is supported by an authoring system which is based on the hypermedia authoring tool SEPIA [Streitz92].

The presentation of Didactic Networks in the classroom

The presentation of a lesson is accomplished by navigation through the corresponding Didactic Network. The multimedia material that is invoked when a node is visited is presented on the electronic blackboard by the Lesson Manager (compare Abb.2). For each node, its predecessors and successors are presented with three elements each. An icon representing the node's type, a label with the link type which connects both, and a button with the name of the neighbouring node. These buttons can be used to change the actual location in the net.

During the presentation the teacher should be able to inspect the whole network to show an overview of the lesson and to jump swiftly from one node to another that is not directly linked. To do this, the teacher invokes a window in which the whole net is shown. The already-visited and still-not-visited nodes are distinguished with different colors. The nodes of this graph are sensitive so any node can be visited by clicking on it.

Expansion of the Didactic Networks to include WWW-nodes

The approach is to support the integration of WWW-nodes as part of the authoring system. WWW material is integrated into lessons by incorporating it as a new node type in the authoring environment. Therefore, all advantages concerning management functions are inherited by the new node type. Their use is similar to the other one's use and improves the handling of WWW material during the preparation phase.

The content of a WWW-node during the preparation is an URL address. When the node is invoked (during presentation or by checking its content during the authoring phase) the HTML-viewer is called and the current content of the page is shown.

The principal reason to include only the URL address and not the entire document is that the presenter may be interested in seeing the current data stored at this address which has perhaps changed since the previous preparation step. Normally, this is an intended situation for topical information like news or weather reports.

For easier management, the author can request from the system a list of all the links that a certain page may contain and select one of them. Afterwards, a new WWW-node with that URL which will be connected to the network as a successor node of the current node can be generated automatically .

Technically, the HTML-viewer is controlled by the Lesson Manager (see Pict. 2) The implementation of this control is made by a DDE interface. It mediates the communication between the Nestcape API and the Lesson Manager.

Based on this control, WWW-documents can be integrated to the presentation environment. If a WWW-node is invoked during the presentation, the HTML-viewer is started. Through its API the viewer receives the URL which should be loaded. In communication between the HTML-viewer and the Lesson Manager is Netscape the server and the Manager the client.

Expanded presentation functions

The integration of WWW-nodes into the presentation environment enhances the management functions for didactic purposes during a lesson. It solves the following problems:

- In big WWW-documents, it is not easy to get an overview of all the links that point to other documents.

  A standard WWW-document that is not prepared for didactic purposes will not serve as a guide to further information. Though an overview of contained links is not offered, it is necessary because of their unstructured distribution in a document. The presentation environment changes this situation by adding prepared guiding links between documents.

- The search for the "origin of information" may not be possible.

  To go to the "origin of information" is also possible with the aid of the presentation environment.

- Pages are often too big and extensive scrolling may be necessary.

  Scrolling for searching links that are located in a very different position in a document could be avoided by using an additional link to the presentation environment. This improves the orientation for the presenter as well as for the listeners.

Perhaps similar advantages could be achieved by the development of a specialized HTML-viewer instead of an embedding system. This could eliminate some problems by having the document shown in an adequate format and by the intelligent processing of the document. The problem is however that the construction and up-to-date keeping of an HTML-viewer would demand too much work and would be soon out of date.

Our solution is an external control of an existing HTML-viewer. The inclusion of WWW-nodes achieves the following goals:

Integration of WWW-pages in such a manner that they are included swiftly as integral parts of a lesson or presentation which may include WWW and non-WWW material. The aim of the integration of WWW-nodes is to enhance the presentation possiblities and to extend the information

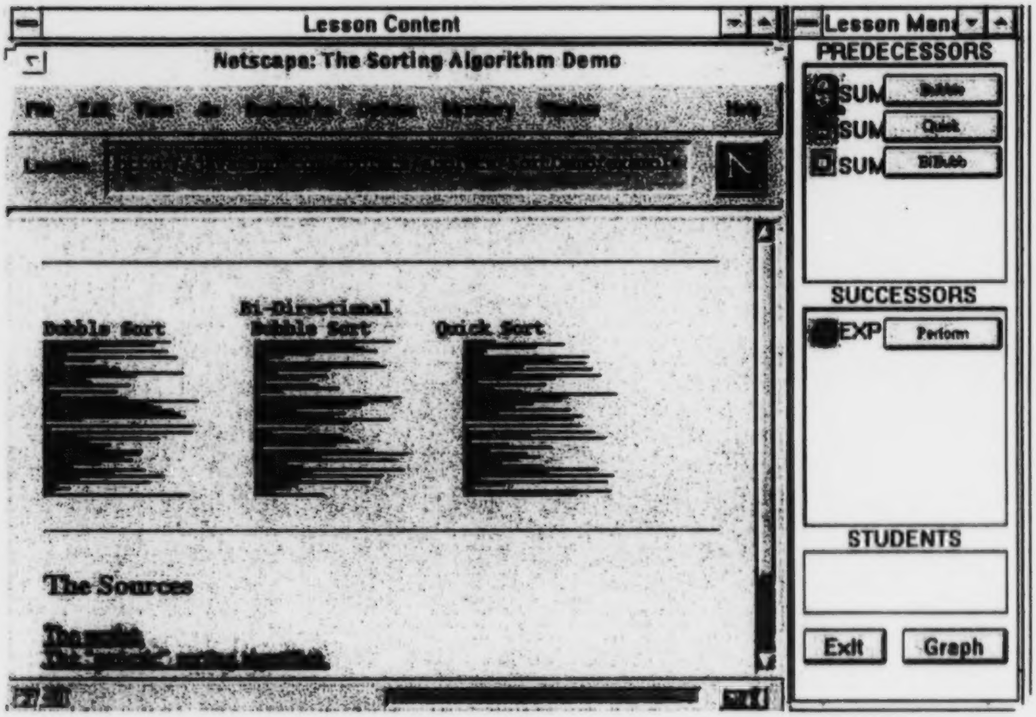
Lesson Content
Netscape: The Sorting Algorithm Demo
Bubble Sort
Bi-Directional Bubble Sort
Quick Sort
The Sources
Lesson Man
PREDECESSORS
SUM
Bubble
SUM
Quick
SUM
BiBubb
SUCCESSORS
EXP
Perform
STUDENTS
Exit
Graph

Abbildung 2: **Integration der WWW-Knoten**
At the right hand side the Lesson Manager is depicted. One can see at the top the predecessors and under them the successors of the node being currently visited. According to the node's content there are sometimes at the bottom right buttons to control the interaction with the learners (send learning material and start student's program). An enter for each neighbouring node consists of a symbol for the node's type, an abbreviation of the link's type and a labelled button to invoke the node. The bigger window at the left shows the content of the current node which in this example consists of a WWW-node with page containing Java-applets.

pool for selecting the material. The integration of WWW-nodes to a presentation environment also includes more flexibility to combine HTML-documents and other tools, especially multi-media material.

Dealing with HTML-nodes during the presentation

About the authoring style and common practice of the documents existing in the WWW we can say that in general, the links of the HTML pages point to pages which display related content or details of the anchored text or image. Thus, the link structure is more content oriented. In contrast, the link structure in Didactic Networks has didactic purposes. The overlapping of the WWW link structure with that of the Didactic Network arises with the inclusion of WWW-pages in the presentation which may complicate the navigation.

At first glance, disabling the HTML links may seem a good solution, but this limits the possibility of searching for new information during the presentation. In our opiniion, a better solution is to keep this overlapping structure and regard a WWW-node as one entry to the WWW during the lesson.

The problems resulting from the overlapping and, therefore, confusing link structures could also be minimized by including all the WWW-pages that one would like to show in the Didactic Network

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as a WWW-node when possible and avoiding the use of the WWW-page links.

Commentaries and Perspectives

With the inclusion of WWW-pages in the Didactic Networks we give the teacher or presenter the possibility of selecting presentation material and information from the widest and fastest expanding pool of multi-media information with free access. It seems that in the near future serious attempts to develop computer based teaching or presentation systems should consider the WWW as one of the main information and presentation material providers.

This system now allows a way of organizing WWW-pages in such a manner that:

- It is possible to organize a lesson with WWW and non-WWW material.
- It is possible to link WWW pages that were originally not connected without having to change the content (links) of any of them.
- It is possible to organize a coherent lesson with WWW-documents maintaining the overview of the structure even in a complex situation.

The labelled links not only support the authoring process of a lesson, but also serve to support the teacher during the presentation.

The approach described above will be expanded in the following way: Under certain conditions, it may be possible for the teacher to ask the system to give suggestions about the next node to visit. This decision-taking engine should be parameterized with the teacher's profile for the current lesson, for example preferred teaching style. An inductive approach would choose to visit the neighbouring nodes pointed with "exemplified by", while a deductive approach would prefer those pointed with "explained by" or "refined by". Also the teaching history (visited nodes) would be considered.

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Electronic Performance Support Systems and Information on Demand

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Abstract: Electronic performance support has become an important technique for improving skills and enhancing knowledge acquisition. This paper discusses the rational underlying the use of this technique, identifies some basic principles and illustrates their use through a case study involving 'information on demand' as a necessary requirement for efficient and effective problem solving.

1. Introduction

We live in an era of unprecedented change and uncertainty. Increasingly, this has meant that organisations have had to compete more aggressively for the basic resources that are needed in order to survive in a rapidly changing world. They have thus had to maintain their competitivity through various types of internal reorganisation and the development of new products and/or services. Furthermore, in order to sustain their growth, most organisations have had to put into place a variety of different mechanisms to maintain existing client bases and, at the same time, develop new markets for their products and services.

Undoubtedly, within most organisations the demands of a dynamically changing environment has necessitated the realisation of many internal programmes of re-adjustment. Inherent in these programmes of organisational change is the need for a continual re-assessment of the nature, structure and function of the various departments and work groups that make up any given organisation. Invariably, re-structuring and reorganisation implies changing job roles. This, in turn, implies the need for post-holders within an organisation to acquire new skills and the knowledge needed to fulfil different job functions.

Within many organisations, situations of the type described above have created a requirement for new approaches for the provision of in-house learning and training opportunities for staff. Invariably, these involve the use of powerful, interactive multimedia computer-based systems that embed a wide range of courseware products that are designed to meet the training needs of the organisation. Computer-based training (CBT) was one of the first techniques to emerge from the use of this type of equipment [Dean and Whitlock, 1988]. However, many other approaches are also feasible. Some typical examples of the more recent educational paradigms that are now being used to facilitate in-house staff development include: 'on-the-job' training, 'education on demand' and 'just-in-time' training. Along with many other important techniques for information handling and provision, these paradigms form the basic foundations for the development of sophisticated job support tools. The development of these computer-based tools for use as performance aids within organisations has led to the creation of a new area of endeavour referred to as *'electronic performance support'* [Gery, 1991; Banerji, 1995].

There is considerable evidence to show that when performance support techniques are introduced into an organisation they can be used to facilitate significant improvements in the work-place performance of individuals, work-groups and other organisational units. Usually, these improvements manifest themselves in terms of efficiency gains, cost reductions and enhancements in the quality of the products and services involved. The cumulative effect on the organisation itself is therefore seen in terms of enhanced productivity and greater competitivity in the market place.

Because of the widespread and growing importance of the role of performance support within organisations, this paper discusses some of the current developments taking place in this area. It commences by outlining the basic nature of electronic performance support. It then goes on to describe a simple *'four-layer model'* and an associated set of *'Principles of Performance Support'* that can be used to help design electronic performance support systems. A simple case study is then presented which describes the development of facilities to provide 'information on demand', that is, it illustrates the role of mobile computing equipment as a mechanism for providing global access to information held on a remote in-house intranet facility. The paper concludes with a short discussion of some of the future possibilities for the use of these techniques.

2. What is Performance Support?

All organisations engage in activities that are designed to further their (sometimes conflicting) goals and objectives. Goals and objectives are realised through the successful completion of 'job sequences' and 'tasks'. As we shall discuss in the following section, each of these types of activity, in turn, often involve various aspects of problem solving.

Within any given target organisation, it is convenient to identify 'task domains' in which people are involved. A task domain (or work area) provides a context and environment for the execution of those tasks that are necessary for the fulfilment or organisational goals. Associated with any given task domain are: (1) a set of relevant and appropriate skill levels; and (2) acceptable levels of prior knowledge of the domain tasks. Expert performance in a task domain will therefore usually depend upon meeting each of these criteria - as well as being able to utilise (in an effective way) any performance aids that are available.

Obviously, people who are involved in task execution within a given domain will be subject to their own innate physical and cognitive limitations - for example, how rapidly they can respond to a stimulus, how much they can remember and how quickly they can perform a mathematical computation. Therefore, bearing in mind such limitations, the area of performance support is concerned with the design and creation of tools, techniques and mechanisms that will improve human performance beyond the limits set by innate natural ability. A performance support system can thus be used to develop augmented levels of achievement within particular task domains. As was mentioned in the previous section, computer-based systems are now increasingly being used as performance support tools because of the powerful multimedia, hypermedia and communications facilities that they make available.

Within the work that we have been undertaking in this area, we have regarded an electronic performance support system (EPSS) as a computer-based interactive guidance and information support facility that is integrated into the normal working environment of an individual or work-group [Barker and Banerji, 1995]. In our current research into 'multimedia performance support systems' we have been particularly interested in the various ways in which multimedia and hypermedia techniques can be used to improve the performance of task operatives within particular application domains. This has involved trying to identify a model for the role of multimedia techniques within the context of EPSS [Hudson, 1997].

The importance of multimedia and hypermedia within electronic performance support systems is reflected in the definition given by McGraw who defines an EPSS as 'an integration of artificial intelligence (AI) technologies, hypermedia and CBT' [McGraw, 1994]. Her view of an EPSS is therefore based on a system 'whose components include embedded training, hypermedia help, AI-based coaches and an adaptable, model-based user interface'. Although embedded training is usually an essential aspect of performance support, it is important to realise that an EPSS facility differs from a CBT system in a number of important ways. These differences are discussed in detail in [Varnadoe and Barron, 1994].

In her recent research, Gery identifies three basic type of EPSS facility which she refers to as: intrinsic, extrinsic and external [Gery, 1995]. Within an intrinsic system the support that is provided is so inextricably integrated with the software design that it is basically seen as the software itself. In an extrinsic support system, aiding is integrated with the software, but it is not part of the primary display; such support can be turned on and off and must be actively invoked. Finally, external support (which may or may not be computer-mediated) is not actually integrated with the work context; the performer must therefore break context and access something that is clearly different from being supported while situated in meaningful work. The way in which these three different types of EPSS facility relate to each other is illustrated in the case study that is presented later in the paper.

3. Basic Principles of Performance Support

As a result of their exploratory research into the design of electronic performance support systems, Banerji and Barker have formulated a basic 'four layer' *model for EPSS* [Banerji, 1995; Barker, 1995]. This model was intended to act as an orientation facility which could be used to draw a designer's attention to the important design issues that need to be addressed during the design of an EPSS. The four layers involved in Banerji's model were: (1) the end-user interface; (2) the generic toolsets; (3) the application specific toolsets; and (4) the application domain itself.

At the topmost level, the human-computer interface is a critical component of the overall system since it provides users with a mechanism for accessing and controlling the facilities available at lower levels. Text-based command-line interfaces, graphical user interfaces and the selection of appropriate metaphors are therefore important design considerations at this level. As is reflected in levels 2 and 3, we make extensive use of toolset metaphors within the end-user interfaces of the EPSS facilities that we design.

The generic toolset level of the model provides a wide range of tools for use within the EPSS. At this level a designer must select that combination of toolsets that is most appropriate for the target application. The toolsets available include: help systems; documentation support (both paper-based and electronic); text retrieval; intelligent agents; tutoring and CBT facilities; end-user modelling facilities; simulation and surrogation tools; communication tools; and so on. As was suggested above, within this level of the model the system designer can 'pick and choose' the types of tool that are best suited for the target EPSS depending upon the functions it is expected to perform. The way in which some of the more commonly used generic toolsets map across onto the required EPSS functions has been described in detail in [Stevens and Stevens, 1995].

Level 3 of the EPSS design model deals with the application orientated toolsets. These are used to perform various tasks within the application domain. The tools in this category may already exist within the application domain or they may need to be specifically built for the target system. The target application itself, for which the EPSS is being built, lies at the lowest level of the model (Level 4). Obviously, the EPSS that is finally produced must integrate smoothly, effectively and seamlessly into this level.

As well as formulating a primitive architectural model for EPSS production, Barker and Banerji have also derived a set of ten basic *'Principles of Performance Support'* and a series of guidelines that could be used to facilitate the practical application of the principles in any given EPSS design situation. Obviously, when designing an EPSS facility, it is important to realise that in any given situation, not all of the ten principles will necessarily apply. It is therefore necessary to identify that subset which is the most relevant and applicable to the situation being considered. The way in which this is done is illustrated by means of the case study that is presented in the following section.

4. A Case Study - Information on Demand

This section of the paper presents a case study that illustrates the way in which performance support techniques can be used to improve an individual's problem solving ability through the provision of easier access to information as a result of the use of mobile computing equipment. The case study is organised into three parts: the first gives a brief description of the scenario; the second identifies and presents a statement of the principles used; and the third gives an outline of the solution itself.

The scenario is as follows: an academic who frequently travels away from his university needs to keep in touch with his research colleagues. His travel takes him to a variety of national and international destinations. While he is away from his campus, he also needs to be able to process his electronic mail and gain access to both his personal files of information and the university's corporate data files. The material that is to be accessed exists on an in-house intranet facility and on various Internet and World-Wide Web servers that are located at his university base.

The three principles of performance support used in this study are referred to by Banerji and Barker as Principle 1 (P1), Principle 3 (P3) and Principle 4 (P4) [Banerji, 1995; Barker, 1995]. The first of these principles states: specify and prioritise the critical areas of under-performance within the application domain and then identify appropriate strategies to improve performance. The next important principle (P3) recommends: identify relevant generic and application-oriented tools and processes which will provide on-the-job support and improve task performance. The final principle that was used in this study (P4) suggests: attempt to identify and, if possible, eliminate all unnecessary information blockages and constrictions within an organisation or a work environment.

The final solution to the problems identified in the scenario above was based on a practical realisation of the three principles just discussed and involved the use of mobile computing equipment [Barker, 1996]. The relationship between the mobile computing equipment and the fixed facilities located at the lecturer's university base is illustrated schematically in [Fig. 1].

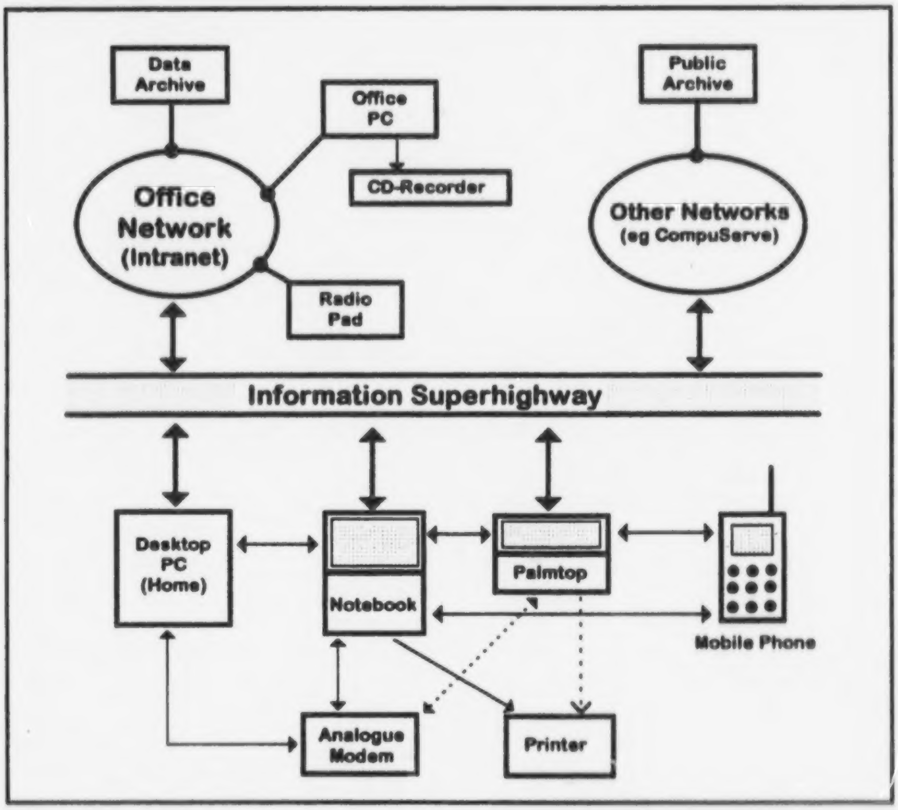

Figure 1: Basic technology to support information on demand.

As can be seen from [Fig. 1], three basic transportable items of equipment were required: (1) a PC-based notebook computer running Microsoft's Windows (Version 3.1) that was equipped with a PCMCIA fax/modem card; (2) a hand-held palmtop computer (a Psion 3a) to which could be attached a serial fax/modem link; and (3) a digital mobile phone (a Nokia 2110) that could be connected either to the palmtop computer or to the notebook. The palmtop and notebook computer could also be connected together to facilitate local data exchange. As well as using the Windows 'Terminal' software, the notebook computer also had a Netscape web browser installed on it. The communications software on the palmtop was a simple VT100 emulator. Although the palmtop could not use Netscape, it was able to use the 'Lynx' text-based browser.

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Although the combination of equipment described above cannot be guaranteed to provide 100% availability of information, it does substantially improve the academic's access to his remote resources. Provided that there is service coverage in the area where he is working, the digital phone can be used to provide 'roaming' access. If connection via the digital cellular network is not possible then the analogue phone system can be used to provide reliable access to his remote information - provided a suitable telephone socket is available.

Bearing in mind what has been said above, we are now trying to develop information handling strategies that will reduce costs and minimise the inconvenience caused by not having 100% roaming access to information. The solution that we are proposing involves the use of portable mobile digital libraries (that are published on optical disc) and the implementation of `virtual office' systems using the World-Wide Web. Details of this work are presented elsewhere [Barker, 1996; Beacham, 1997].

5. Conclusion

The principles underlying electronic performance support provide a powerful framework to facilitate the design and development of job support aids and productivity tools. Such performance enhancers can be used to enable individuals, work groups and organisations to overcome many of the problems that they face as a consequence of natural human limitations and the constraints that they impose. Within this paper a simple model for EPSS development has been proposed along with an accompanying set of basic principles of performance support. The way in which these principles are used in order to solve a `performance' problem has been illustrated by means of a short case study involving the provision of facilities to support `information on demand'. Our future work into EPSS methods is aimed at trying to identify further fundamental principles of performance support based upon the use of multimedia, hypermedia and distributed systems technologies.

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Methods and Practice of Software Evaluation. The Case of the European Academic Software Award

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Abstract: The paper discusses theoretical and methodological problems of software evaluation in Higher Education. It criticizes the commonly used approach in product evaluation using numerically weighted lists of criteria. On this basis, an alternative method with qualitative weighting is presented. The European Academic Software Award held in Klagenfurt/Austria in 1996 (EASA '96) serves as an example of the practical implementation of this method, whose outcome is reported at the end of the paper.

1. Motivation

The evaluation of interactive media becomes more and more important: on the one hand because of the growing offer of software from which good products have to be chosen, on the other hand in order to promote software quality and to set quality standards. In the domain of academic software, the EASA was created with these considerations in mind.

The aim of EASA is to promote the development and use of software in research and higher education. There are two main aspects to this aim, reflected by the definition of "academic" software as either software *for use in* higher education and research, that is, educational software, but also tools for teaching, learning, and research, or as software developed *in* higher education and research. The award is intended both to make software producers and distributors aware of innovative ideas and programs developed in the academic world and to point out to the academic audience good examples of technology-enhanced teaching and learning.

The original focus of EASA being the promotion of new developments excluded the use of certain evaluation approaches, like, for example, a quasi-experimental design (comparison of reference groups by pre- and post-testing). At the first EASA (Heidelberg, 1994), the evaluation was done instead by expert groups using lists of criteria.

2. Evaluation with checklists

In checklists, the features that are considered necessary and/or desirable in the product that is to be evaluated (the evaluand) are listed, and the product is rated for each feature. This method has a number of advantages: It is

- *cheap*: one expert, one licence of the program and the suitable hardware configuration are in principle sufficient to evaluate the software and fill in the checklist.
- *easy to organize*: the software need not be assessed in a situation of real use (classroom), evaluation can be assigned to a specialized (and centralized) group or institution removed from the context of use.
- *at first view, methodically "clean"*: by going through the same, often voluminous checklists in each examination, the method appears to be objective.

However, this method is insufficient for different reasons:

- The practice of establishing lists of criteria and of working through them in the evaluation procedure does not avoid the problem of weighting the different features to come to a final conclusion: "No software is perfect. Every item has strengths and weaknesses. It is the evaluator's job to identify those virtues and defects and then decide which outweigh the others. - It is a judgement call." ([Doll 1987], p. 58). But it is exactly this "judgement call" that has to be methodically clean, and this is the methodological problem the present paper focuses on.
- Another problem lies in the assumption that the usefulness of educational software can be assessed in a context-free judgement. Often, however, it is not the product (piece of software) itself but the innovative use that is made of it that guarantees the positive learning effect. For this reason, future EASA evaluations will include case studies and shift the focus of the assessment from the product to the learning situation.

3. The Logic of Evaluation

Basically, "evaluation is the determination of a thing's value" ([Worthen and Sanders 1987], p. 22), or, as Scriven ([Scriven 1991a], p. 1) puts it: "Evaluation is the process of determining the merit, worth and value of things, and evaluations are the products of that process."

This definition implies that in the center of every evaluation is the formulation and assignment of a value judgement. In this sense the logic of evaluation are different from other disciplines (e.g. social research).

- Formulation of value criteria: First, those criteria that the evaluand has to satisfy in order to count as valuable or good are selected and defined.
- Formulation of standards: For each criterion, a standard or norm has to be established. Only if the evaluand comes up to this standard, it is considered as satisfying the criterion.
- Measurement and comparison (analysis): The evaluand is analysed and measured on each criterion and compared to the predefined standards.
- Value judgement (synthesis): In this last and most difficult stage of evaluation, the individual results of measurement and comparison have to be integrated into a single value judgement.

Each of these steps or stages gives rise to certain problems:

- *Formulation of criteria*: Which criteria should be chosen? What importance (weight) should be given to each criterion for an overall assessment? Note that this is mostly a theoretical question whose answer needs a thorough analysis of the evaluand. The attempt to arrive at a complete list of criteria by putting together all existing lists (as done, for educational software, by [Thomé 1989], who collected 324 individual criteria from which she compiled a "Long Checklist for Educational Software" with 221 criteria) does not solve the problem, because it does not guarantee neither that the criteria are independent of each other nor that they are really of equal importance.

- *Formulation of standards*: This implies that criteria have to be operationalized, which has not yet been done for the majority of the criteria usually applied to educational software. For example, how should "interactivity" be measured? Based on the analysis of the evaluand (in our case: of theoretical assumptions about academic software) we can distinguish three main levels of standards:

- Level 1 = Requirements or needs (necessitata): These must be satisfied in any case if the evaluand should be included in the further evaluation procedure (k.o. criteria). They are essential criteria that every evaluand must have or fulfill, for example: a certain educational software cannot be used if it does not run with the existing hardware.
- Level 2 = wishes or desiderata: These are functions and features that are not mandatory but useful. They increase the value of the evaluand and are important for the final value judgement (e.g ranking). They have to be defined and weighted in a way that mirrors the evaluation goal. (For examples cf. the list of criteria used in the EASA Competition in [Tab. 1])

  Two commonly made mistakes are: (a) Too many and too detailed criteria, whose number and collective weight inundate the evaluation process and complicate the synthesis needed for the final value judgement. (b) A bias towards certain features results from criteria that "overlap" (= are not independent of each other).
- Level 3 = ideals: Although they can hardly be reached, they provide an important perspective by pointing to ways in which the evaluand could be further improved. This is especially important for formative evaluation, where the evaluand is still under development. Most of the EASA criteria can also be used for program improvement, and actually this is one of the motives of this award: to raise the quality of academic software.

- *Measurement and comparison*: This stage depends on the previous operationalization of criteria. Where this is - as in the case of interactive media - still under way, no generally approved, tested and normed scales are in use. Instead of objective measurement, we therefore had to rely on dialogue and intensive discussion between jurors and authors and among the jurors themselves. Contrary to an objectivist point of view, we do not consider this to be a shortcoming. In expert groups a certain element of subjectivism helps to integrate different opinions. Often the qualitative assessment is a preliminary stage for the establishment of an accepted standard that finally can lead to a quantitative evaluation procedure. We doubt, however, that this will ever be the case with educational software.

- *Value judgement*: The integration of individually assessed criteria into one value judgement implies a prior definition of the role or weight of each criterion. Such a definition has to be based on the theoretical assumptions that have to guide the evaluation procedure. At last year's Ed-Media Conference, we proposed a detailed theoretical framework that can be used as a heuristic model for such an assessment ([Baumgartner and Payr 1996a]). In this paper, we will therefore concentrate on the methodological difficulties. Let us first compare two methods commonly used for the weighting of criteria in product evaluations - numerical vs. qualitative weight and sum.

4. Methods of Weighting

4.1 Numerical Weight and Sum (NWS)

This method is frequently applied and can take different forms. The general form is called multi-attribute utility analysis ([Scriven 1991b], p. 380f.): 1) The relevance (weight) of each criterion is set using a scale from e.g. 1-3, 1-5 or 1-10. 2) The evaluand is rated for each criterion. 3) Rating multiplied by the weight gives the result for each criterion, results are added up for each evaluand. 4) The final result is a single number for each evaluand. The evaluands can be ordered by this number (ranking), the one with the highest score being the "winner".

This method has a number of intrinsic problems:

a) By attributing and adding numerical values, this method assumes a linear scale of utility for all criteria. But this assumption is clearly wrong! At the moment there is no normed, tested, standardized and agreed linear scale for the quality of educational (or academic) software and it is doubtful if there will ever be one. As it stands, the different components or dimensions must not be added up to a single final number.

b) The multiplication used for weighting also presupposes a metrical scale where a zero value makes empirical sense, which is not the case with many criteria. It could maybe make sense-, for example, with the criterion of "documentation" (from "no documentation at all" to "all features are documented"), but any other question like "is the documentation adequate, clear and useful?" can only be answered on an ordinal scale (like: "sufficient - good - excellent") that allows ranking, but not calculation.

4.2 Qualitative Weight and Sum (QWS)

This alternative method overcomes the methodological difficulties of the numerical approach and consists of three main steps:

1st step: Constructing the list of criteria
As in the NWS method a list of criteria is established and weighted. The crucial difference is that QWS is not based on the assumption of an interval or ratio scale. In order to prevent the possible confusion with numeric operations that are only legitimate for linear scales, Scriven ([Scriven1991b], p. 294) recommends the use of symbols for the weights. Frequently used symbols are: E = essential, * = very valuable, # = valuable, + = marginally valuable, and 0 = zero.

2nd step: Weighting of criteria
The weight of a criterion determines the range of values that can be used to measure an evaluand's performance. For a criterion weighted #, for example, the evaluand can only be judged #, +, or 0, but not *.

Three rules help to execute complex product evaluations, e.g. evaluations with many evaluands and many different components or dimensions:

1) *Elimination of evaluands:* An evaluand that does not satisfy a criterion considered essential (E) is eliminated. In our case, such a criterion could be, for example, if a software crashes. Such a criterion can already reduce considerably the number of evaluands. But the process of elimination is not always as easy as the example suggests. Essential criteria often are not "all or none" criteria, but establish a certain minimum standard of performance. For example, response time of a software must not be longer than a certain limit (set by psychological factors), but inside this limit the variation of response time does not make a substantial, qualitative difference.
2) *Elimination of 0-criteria*: Every criterion that gets the weight 0 in the weighting process can be eliminated - it is judged irrelevant.
   The remaining evaluands (after applying rule 1) are now evaluated by attributing a value for each remaining criterion (after applying rule 2) up to the maximum weight. If a juror does not feel sure or has any doubts he/she can put a value in brackets, so that this criterion for this evaluand is marked for further analysis or comparison.
3) *Elimination of criteria with uniform results*: Criteria where all evaluands have reached the same level can be eliminated from further consideration, based on the assumption that all evaluands are more or less equal in this regard and that the criterion therefore does not contribute any distinctions.

3rd step: Ranking
Counting the different symbols given to each evaluand results in three numbers for each evaluand - the number of *, of # and of +. The evaluands can now be ordered (ranked) according to these numbers.

This ordered list can either be used for grading, e.g. for cutting off a certain proportion of evaluands either on top or on bottom of the list, or it can be the basis for determining a "winner" and a ranking of results. For a definitive ranking, however, results have to be analysed more closely. There is no doubt that an evaluand with 3*, 4# and 2+ is better than one with only 2*, 5# and 2+, but it is not clear whether it is better than one with 2* and 7#. It may be necessary to analyse and compare these two candidates more closely.

It may also be necessary, in case of unclear results, to proceed to a second round of weighting. The method of QWS is not only complex, but also has this disadvantage of not offering a clear decision algorithm. Sometimes it has to be applied several times and the evaluations have to be redone in the light of previous results.

5. QWS Applied to EASA

The method applied in the final evaluation round of the EASA was a variety of QWS ([Baumgartner and Payr, 1996b]). It departed from the general method as outlined above mainly by not using the E symbol or essential criteria. The reason for this was that the programs admitted to the final stage of the competition had already been tested and pre-selected, so that they could safely be assumed to satisfy a certain minimum standard for the criteria that played a role here (they were, of course, functional and virus-free, but the pre-selection had also looked into aspects of educational use, language, design and innovation). The shortlisted projects (35 out of 157 submissions) were invited to the final event, together with 20 jurors drawn from the jurors' body established in the pre-selection round and 5 additional student jurors. The authors set up their software in an exhibition-style setting. The evaluation process took two days, starting with an introductory session where the "rules of the game" were established, and ending with a plenary session where the final decisions on the award winners were endorsed.

5.1. Weighting of Criteria

A list of 12 criteria ([see Tab. 1]) was proposed to the jurors. The jurors attributed the value of *(very important), # (important, relevant) or + (additional, less important) to each criterion. This specific expert group considered all 12 criteria at least "important", but most of them "very important" (criteria 3, 8 and 11 had #, the rest *). So the jurors gave themselves, for most criteria, the broadest possible range of values to attribute in the following evaluation round.

5.2. Evaluation

For the evaluation, jurors worked in five sub-groups. Each of these sub-groups had to evaluate seven programs. They had a whole day for examining the programs and the documentations and for requesting additional information from the software authors. The jurors filled in their evaluation form for each software individually and then discussed it in their sub-group to come to a single group evaluation. Only this group result was taken into account for the subsequent ranking.

5.3. Ranking and Discussion of Results

The next day, the evaluation results were presented to the plenary session of jurors in the form of tables where not only the integrated results (the number of * etc. for each software) were made visible, but also the result for each criterion, including bracketed symbols and cases where jurors considered a criterion not to be applicable. Moreover, these tables were arranged and presented under different aspects, like submission category (department projects, student projects, and commercial projects), country of origin, and discipline. This documentation was necessary as a basis for the discussion of the results. Certain aspects had to be analysed before coming to a decision:

- Are the results consistent, i.e. have the groups applied comparable standards when attributing values for each criterion, or are one group's results constantly lower or higher than the rest?
- Is an overall good result, but without any highlights, i.e. twelve #, but no * - preferable to a software with some outstanding features, but also with some weaknesses - i.e. six * and six +?
- How many awards should be given away, and in which categories? For example, if the best program of a certain award category comes very late in the overall ranking, is it still good enough to get an award, or should this award be left out?

- Does the resulting list of award winners represent the different disciplines, countries, submission categories etc. well enough?

EASA '96 Evaluation Criteria

1. Correctness: Is the subject material accurate and up-to-date? (For tools:) Is the program functional?
2. Relevance: Does the software correspond to real user needs? Is the contents relevant for teaching and learning in the subject area?
3. Coverage: Is the subject material sufficiently covered? Does the software cover an important part of the subject area? (For tools:) Is the range of functionality appropriate?
4. Interaction: Is the software highly interactive? Does the software encourage active/exploratory learning? Does the software create and maintain learner motivation and interest? (For tools: not applicable)
5. Learning: Is the material well structured and organised in order to support the learning process? Are learning objectives defined and can they be attained? (For tools: not applicable)
6. Usability: Is the software appropriate for the target group it addresses? Can the software actually and easily be used in research, teaching and learning? Does the software run on current students'/universities' computers?
7. Navigation: Can users always see clearly where they are in the program and what actions/functions are available? Does the software always show its current staturs, mode? Are reactions of the program to user actions clear and appropriate?
8. Documentation: Is online help available? Are manuals, tutorials etc. available? Is the documentation clear and useful for the target group?
9. Interface: Are contents and functions well organised on the screen, easy to learn and used, and well presented? Does the software follow the known standards of interface design? Does the software satisfy ergonomic requirements?
10. Use of computer: Does the software support activities, forms of teaching and learning that are not or not easily feasible otherwise? Does the software make adequate use of the medium?
11. Adaptability: Can the software be easily updated and adapted to new contents and teaching/learning requirements? Is the software portable to other European curricula and languages?
12. Innovation: Does the software contribute new and interesting aspects to educational computing and multimedia? (For tools: ... to computing?)

Table 1: Evaluation Criteria used for EASA '96

In the case of EASA, no single "winner" had to be found, so that the method was used for a process of apportioning: a group of award winners had to be cut off from the rest of the finalists (who, in their turn, were already considered "winners" of some sort, having reached the final stage of the competition).

The plenary discussion had, in this case, to take the role of the re-analysis and comparison of evaluands, simply because of the limited time frame.

The results showed a rather clear "top group" that was defined as the award winning group without much further discussion. It only had to be completed with some programs that were promoted from "lower down" in the list, the submission category turning out to be the decisive factor: these additional award winners were student projects, which jurors did not expect to offer the same level of performance and quality as department projects and commercial software.

6. Conclusions

We started out criticizing checklists as a method of evaluation for interactive media, went on to present alternatives and reported the practical experience with the qualitative weight and sum (QWS) method as used by an expert group in the EASA '96.

Applying this method of product evaluation to the EASA can serve as a good illustration of the necessity to come to terms with both theory and practice of evaluation in any specific setting. While theory can clarify the respective merits and shortcomings of different evaluation methods and formulates the critical questions that guide evaluation design, practice sets up inevitable limits of time and cost to any evaluation. What we hope to have shown is that by

- clearly defining the evaluation task at hand
- following the logic of evaluation and
- taking into account the practical limitations

it is possible to design evaluation settings that are theoretically grounded, practically feasible and adequate for their specific purpose and goal.

As there exist plans to broaden the scope of the European Academic Software Award to include not only software products, but also case studies and experiences in the innovative use of software in higher education, EASA will be progressively leaving the field of product evaluation. With these new pedagogic goals in the award, other methods of evaluation will have to be found and tested. So we can look forward to the next EASA which will take place in the U.K. in 1998 (see [http://www.york.ac.uk/inst/ctipsych/easa/]), both for interesting submissions and for new insights into their evaluation.

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Distributed Learning by Distributed Doing

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Abstract: The convergence of several technological trends holds great promise for distributed learning. Faster throughput, better data compression, and reductions in the cost of multimedia desktop computers and peripheral hardware have brought the prospects for geographically distributed instruction within the reach of many institutions and their students. Colleges and universities have thus begun exploring the difficult questions surrounding the design and content of distributed courses. In a survey reported in this paper, we identified three patterns in how higher education was leveraging computer-supported distributed learning: as a resource space, as a discussion space, and as a collaboration space. To determine what influences the outcome of a DL design effort, and to begin articulating how software tools might make such efforts easier, we developed a sample online module and made it available to graduate students. After presenting the results of that trial, we offer recommendations for fostering faculty and student participation in the distributed learning enterprise.

Goals of the Project

Colleges and universities are increasingly cognizant of the importance of extending the reach of their academic activities beyond the campus. Emerging technologies such as desktop videoconferencing and realtime, multimedia Web documents suggest ways of enriching the remote experience in ways that can begin to replace some of what is lost when classes convene virtually rather than physically. Without an established methodology for creating DL instructional material, though, individual faculty must synthesize their own schemes for producing material. Because some of these efforts are likely to result in interesting and powerful approaches, one goal of this research was to survey and evaluate a representative sampling of courses offered using internet technologies (partially or exclusively). Another consequence of the absence of a systematic approach to DL design is that most faculty do not have the time or expertise to augment their courses with technology-supported instruction. A second goal of the study was therefore to construct a sample DL module and apply that experience in articulating how faculty can more readily participate in this enterprise.

Distributed Learning Survey

As a prelude to our course development experiment, we conducted an informal survey of roughly one hundred sites on the Web that offered undergraduate or graduate instruction. From these, we selected twenty four that demonstrated the range of techniques, domains, and effectiveness we encountered among the larger sampling. For each of these, we applied a qualitative instrument to evaluate the materials along several dimensions, including the role of the DL activities in the overall course, the appropriateness of the technologies employed, and a subjective, qualitative rating. The course reviews were posted on the Web in tabular form [Fig. 1]. Since the purpose of the survey was to inform our subsequent design activities, we were interested in what the results had to say with respect to the following two questions: what makes online materials effective?; which technologies are needed for conducting meaningful online instruction?

What makes online instruction effective?

Results from the survey suggest some of the ways in which traditional instruction can be adapted to a distributed format. Our aim is not to discuss specific pedagogies[1], but to develop a set of capacities shown to make important contributions to DL instruction. The twenty-four courses analyzed in the survey were evaluated using a qualitative instrument consisting of six dimensions:

1. Intended Audience - who would be taking the course
2. Course Content - what materials were available online
3. Technologies Used
4. Role of Online Materials - how the online components of the course were used to enhance instruction
5. Appropriateness of Online Materials - how suited the materials were for the technologies employed
6. Level of interactivity - the extent to which communication and interaction were accommodated

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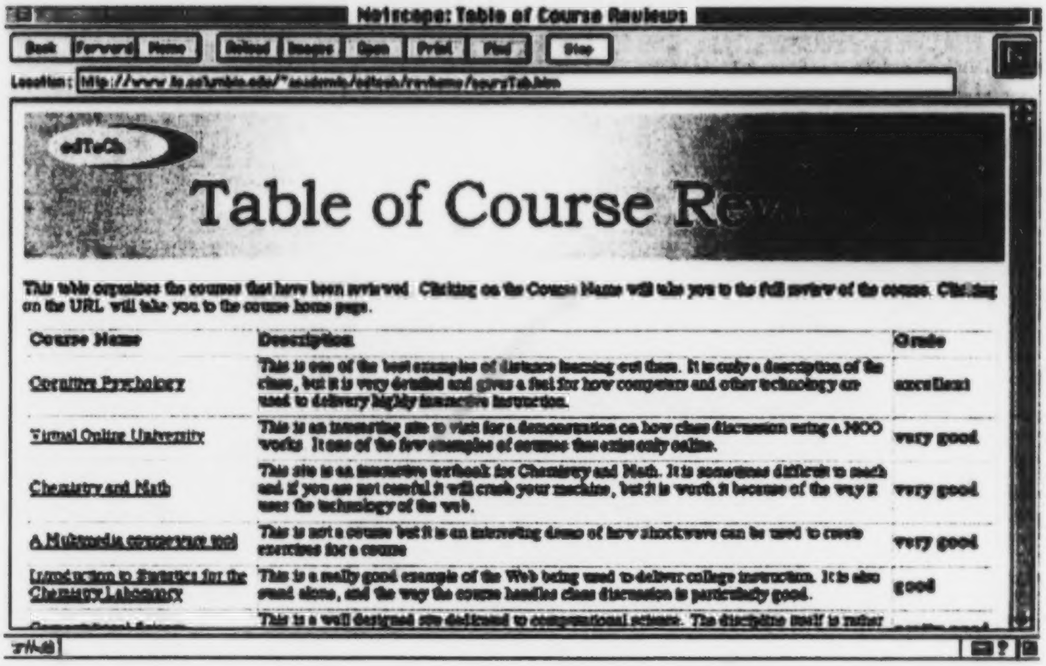
[1] though it is important for tools to possess embeddeded pedagogical models [Bell 1995; Bell 1996].



This table organizes the courses that have been reviewed. Clicking on the Course Name will take you to the full review of the course. Clicking on the URL will take you to the course home page.

Course Name	Description	Grade
Cognitive Psychology	This is one of the best examples of distance learning out there. It is only a description of the class, but it is very detailed and gives a feel for how computers and other technology are used to delivery highly interactive instruction.	excellent
Virtual Online University	This is an interesting site to visit for a demonstration on how class discussion using a MOO works. It one of the few examples of courses that exist only online.	very good
Chemistry and Math	This site is an interactive workbook for Chemistry and Math. It is sometimes difficult to reach and if you are not careful it will crash your machine, but it is worth it because of the way it uses the technology of the web.	very good
A Multimedia courseware tool	This is not a course but it is an interesting demo of how shockwave can be used to create exercises for a course	very good
Introduction to Statistics for the Chemistry Laboratory	This is a really good example of the Web being used to deliver college instruction. It is also stand alone, and the way the course handles class discussion is particularly good.	good
	This is a well designed site dedicated to computational science. The discipline itself is rather	

Figure 1: Segment of Online Course Survey

Most courses in the survey adhered to a traditional style of instruction, in which the instructor specifies some material to be covered and then administers some sort of evaluative exercise, usually a paper or a test. In general we found that the courses which best took advantage of the medium were those associated with the most interactivity, meaning they provided the greatest opportunity for communication among class participants and between student and instructor. Almost all the courses surveyed took advantage of email, but far fewer afforded any real time communication using the internet.

The most highly-rated distance learning courses in the survey shared three attributes. First, they feature access to resources that are comprehensive (in the context of a particular course), as well as thoughtful instructions and clearly defined expectations for the students. These sites incorporate assignment schedules or similar planning milestones, so that students are held responsible for accomplishing specific tasks by specific deadlines. This seems to capture some of the essence of an on-site class in that students have a common basis for discussion of a selected topic, but offers students some control over their own learning processes. Second, these courses are enriched with communication. Among the more highly-rated courses, we observed real time communication elements, through discussion forums, chat rooms, or desktop videoconferencing. Through the use of such technologies, these courses gain some of the immediacy and accountability of on-site classroom interactions. Third, the highly-rated courses accommodated collaborative interchange among students. Some collaboration was observed using the same tools employed for communication, namely discussion forums, chats, and conferencing. In some cases these technologies were augmented by special collaborative software that created a shared work space, such as a whiteboard or shared window that participants could annotate and modify.

We also observed some less effective uses of distance learning. The majority of these were limited adaptations of existing classes in which the instructor posted notes and assignments but made little or no attempt to address the communicative aspects of instruction. This approach is acceptable when the materials are intended to augment a class that physically convenes, but some of the courseware we encountered in this category was presented as being more self-contained than was actually the case. Such sites fail to present the student with anything to do other than view information; they do not include any task that the student is expected to accomplish. In addition to those courses that do not sufficiently leverage the possibilities of internet-enhanced instruction, we encountered some that are just poorly conceived, lacking a coherent navigational path, confusing students, and making it difficult to understand just what students are expected to learn.

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Which technologies are needed for conducting meaningful online instruction?

The best technologies for online instruction are the appropriate ones. The internet can deliver information in multiple media, from simple text to full motion video. From the survey, it appears that certain technologies offer promise for distance instruction when employed in particular ways. Email was used in almost all courses for communication between students and instructors and among students. The most effective way to hold group discussions seemed to be a threaded forum, (*e.g.*, a newsgroup). The more highly-rated courses in the survey incorporated these features directly into their web pages. Chat rooms were used as well, and were especially suited for collaborative concept development and brainstorming. Email seemed to yield better results for this purpose, though, because its non real-time nature allowed participants to more carefully construct their messages. A few made use of simulations, though these were held in files for students to download rather than being available directly within the students' browsing software. Desktop videoconferencing did not appear to be widely used, either because of the time constraints it puts on interaction (conferees must be at a computer at a specified time) or because current low-cost conferencing technologies provide poor image quality and frame rates. However, the two most highly-rated courses surveyed did include some type of real-time communication between student and instructor, either via videoconferencing or chat rooms.

Survey Results: Summary

Accompanying the absence of a standard methodology for DL course development is the reality that no single technology can reproduce the critical elements of the conventional classroom experience. Online courses are therefore often implemented as a cluster of materials supported by disparate technologies. Moreover, technology is a double-edged sword, introducing challenges that can be viewed as barriers, opportunities, or both. Primary among the opportunities is of course the ability to instantly disseminate class-related materials to a global audience at minimal cost. A principal barrier, on the other hand, is the absence of the richly communicative context of face-to-face classroom interaction. The potential for students to collaborate and share their findings is both a barrier (because of the steps required to implement the appropriate connections) and an opportunity (because technology liberates collaborators from familiar constraints such as place, time, and Federal Express). We therefore offer the following three recommendations based on our findings:

- **Resource Space**: DL instruction should include instant global access to all materials relevant to the course, in the most appropriate medium (or media), and compatible with all appropriate platforms. Any collection of materials made available to students should be accompanied by a plan or map that learners can use to guide their exploration.
- **Discussion Space**: DL instruction should accommodate the exchange of ideas, data, and information, between student and instructor, among students, and with appropriate experts and scholars in the field, and should support all modes of communication (text, audio, and video, both synchronous and asynchronous).
- **Collaboration Space**: DL instruction should provide channels for students to engage in joint research, design, development, and distribution of class-related project work, in whatever formats or media are suitable for the domain of study.

Distributed Learning Design

The second phase of our research was to construct an exemplar DL module that would observe in general the three recommendations arising from our survey. The module encapsulates one class meeting of a core course in the design of educational technology at Teachers College, Columbia University, and was tested by students enrolled in a summer session of the course in 1996. We established a framework for our design that defines three functions that the online instruction must serve: resource space, discussion space, and collaboration space.

The resource space

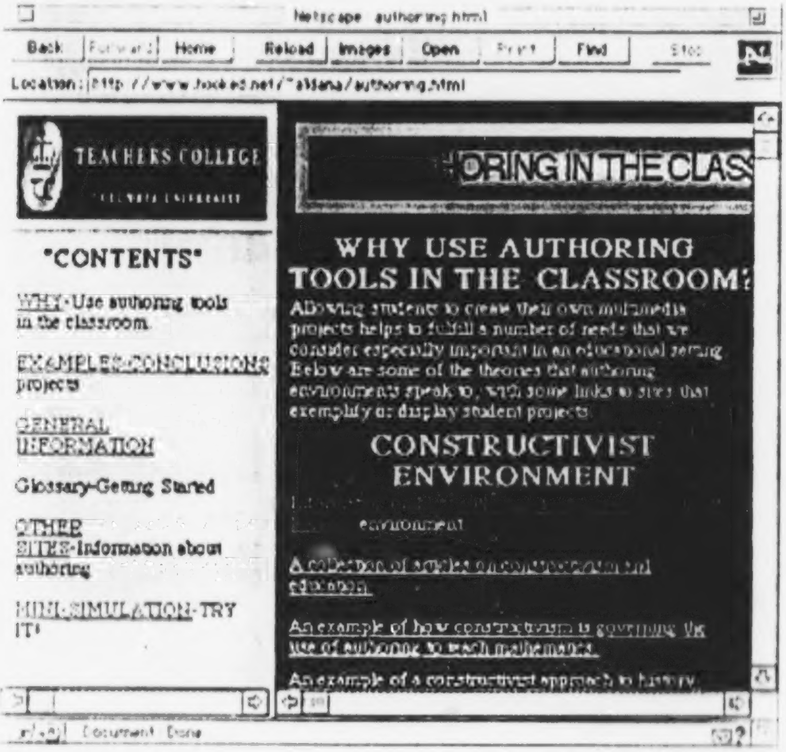
Students enrolled in the course could obtain a range of class materials via the Web. Class descriptions, a syllabus, and assignments were posted to the class web site. Additionally, those readings that were available online were referenced from within the syllabus. Finally, numerous sources of related information were offered via a "related links" section common to most web sites.

The discussion space

The course used in this study included a strong emphasis on discussion, and so an effort was made to preserve that emphasis for the online session. Two types of forums were explored in our investigation: threaded discussion (newsgroups), and real-time, text-based conversation (chat rooms). Both forums were accessible to students using simply a standard web browser.

The collaboration space

Students worked in teams of four or five members to develop a distributed learning "mini-module" to teach a subset of material offered in the course. Collaborative interchange was supported via the discussion groups, shared web pages, and desktop conferencing. At the conclusion of the DL session, students were asked to post their reactions to a discussion group dedicated to this purpose.


Netscape: authoring.html
Back
Forward
Home
Reload
Images
Open
Print
Find
Stop
Location: http://www.tc.edu.net/~aldana/authoring.html
TEACHERS COLLEGE
COLUMBIA UNIVERSITY
CONTENTS
WHY-Use authoring tools in the classroom.
EXAMPLES-CONCLUSIONS projects
GENERAL INFORMATION
Glossary-Getting Started
OTHER SITES-Information about authoring
MINI-SIMULATION-TRY IT!
ORING IN THE CLASS
Document: Done

WHY USE AUTHORING TOOLS IN THE CLASSROOM?

Allowing students to create their own multimedia projects helps to fulfill a number of needs that we consider especially important in an educational setting. Below are some of the theories that authoring environments speak to, with some links to sites that exemplify or display student projects.

CONSTRUCTIVIST ENVIRONMENT

environment

A collection of articles on constructivism and education.

An example of how constructivism is governing the use of authoring to teach mathematics.

An example of a constructivist approach to history.

Figure 2: Opening screen from student-designed distance learning module

Results

Constructing an exemplar DL module provided useful insights into the strengths and deficiencies of online distance instruction. In general the students' responses to the online components of the course were positive. However, although students commented that the discussion forums in particular were useful, there was a consensus that they could not and should not supplant the classroom experience. Each of five project teams created a learning module to teach a topic related to instructional design of educational technology (which was the focus of the course). The topics selected by the projects were Communities of Practice, Exploration Learning, Anchored Instruction, Assessment of Constructivist Artifacts, and Hypermedia Browsing [Fig. 2]. In the course of designing the projects, collaboration was observed in several forms:

- participants made use of the discussion groups to brainstorm and refine their preliminary ideas, schedule meetings, and report progress.
- individual teams maintained their emerging designs on a web server, so that members could share work incrementally and also to invite comment from the class at large.
- teams conducted text, audio, or video interviews via the internet with scholars appropriate to that team's topic area, and posted the results of those interviews as part of their evolving learning modules [Fig. 3].

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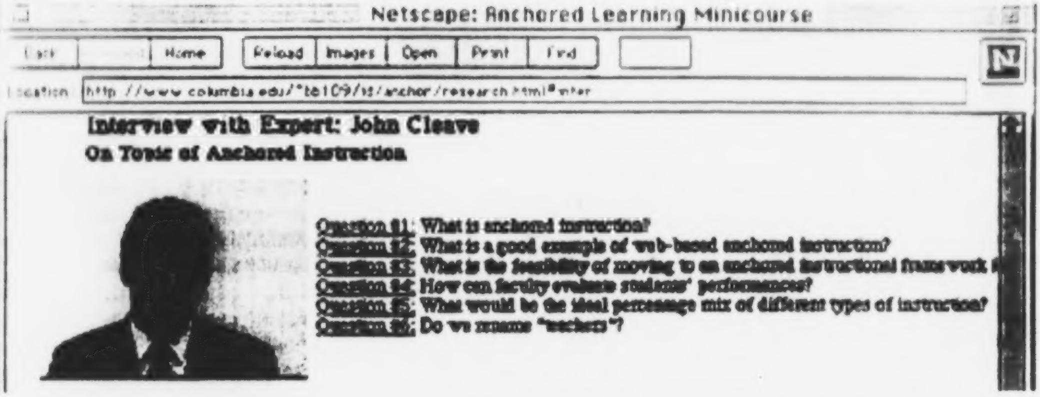
Netscape: Anchored Learning Minicourse
Back
Home
Reload
Images
Open
Print
Find
Location
http://www.columbia.edu/~tb109/it/anchor/research.html#inter

Interview with Expert: John Cleave

On Topic of Anchored Instruction

Question #1: What is anchored instruction?
Question #2: What is a good example of web-based anchored instruction?
Question #3: What is the feasibility of moving to an anchored instructional framework
Question #4: How can faculty evaluate students' performances?
Question #5: What would be the ideal percentage mix of different types of instruction?
Question #6: Do we rename "teachers"?

Figure 3: Expert interview included in student-designed distance learning module

These modules also pointed out the shortcomings of the web as a medium for collaboration. Although the web provided for sharing the product of the collaboration, much of the actual design of the modules was carried out in face-to-face interactions. Students did not view the web as capable of providing both a space in which to create artifacts and a tool for commenting on and altering what was being created. The use of collaborative tools such as ComMentor [Röscheisen, Mogensen, & Winograd 1996] and CaMILE [Shabo, Guzdial, & Stasko 1996] that give students the ability to comment on artifacts within web pages offer promising approaches.

Discussion

Embedding a pedagogical model

Our survey yielded little in the way of distance instruction that observed some explicit pedagogy. The online courses relied overwhelmingly on two kinds of activity: individual exploration of static content, and email (or threaded forums like news) to talk about issues relevant to the class. Whatever instructional strategies might have been employed by those instructors in face-to-face class meetings did not find their way to the online complements to those courses.

We conceived of the class project work as a preliminary step toward embedding an explicit model into online instruction. Engaging students in the construction of DL modules is consistent with the notion of a cognitive apprenticeship [Collins, Brown, & Newman 1989]; students were expected to become instructional designers while working with others in the field of instructional design. Students engaged in creating instructional materials about their selected topic necessarily acquired new expertise in that topic and, equally importantly, were put in a situation where they could immediately apply their new skills and knowledge. The point was not to train students to create distance learning; that task simply served to anchor the exploration of the selected topic. Thus our approach also parallels quite closely both Goal-Based Scenarios [Schank, Fano, Bell, & Jona 1993/4] and Anchored Instruction [CTGV 1990], two models that prescribe an authentic task and an environment in which to pursue that task as a means for learning-by-doing instruction.

Our experience suggests the possibilities for distance instruction as a means for supporting or sustaining communities of practice [Lave & Wenger 1991]. Students in our sessions used telecommunication technologies to interact with experts in the field of instructional design. This use of technology to expand and introduce students to communities of practice is perhaps the most promising direction for future research and implementation given that one of the most important and overlooked aspects of university education is the enculturation that takes place in traditional university settings [Brown & Duguid 1996].

Deficiencies in the Design

The generally positive results from the study were realized despite one principal design flaw: the instructional module lacked any sort of unifying metaphor to assist navigation and to present the resources within some intuitive context. Some of the sites in our survey adopted spatial metaphors, for example, including a campus, mall, or village square. Specific resources could then be identified as "cafe", "library", "post office" and so on depending on the metaphor. Although students' reactions to and use of the DL materials were encouraging, the distance portion of the course was only one session (out of eight total). Students could therefore rely on in-class meetings to resolve any problems associated with the DL material or to simply get

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acquainted. We made no attempt to analyze the extent to which our results could be applied more broadly, though the pedagogical leverage enjoyed by our goal-based approach is likely to be broadly applicable.

Conclusion and Future Work

In this paper we presented results from a survey we conducted of university-level distance instruction. Findings from this survey helped us define an approach to distance instruction that calls for three "spaces": resources, discussion, and collaboration. We introduced a sample distance learning session that was conducted as part of an on-site course in instructional design, and that was created with our survey findings in mind. Because one notable deficiency of the DL material we encountered was the lack of an explicit instructional approach, we created our sample DL module adopting a situated, goal-based pedagogy in constructing the activities.

Our experiences with online distance learning have suggested some positive aspects of online distance learning and have indicated some directions for future research and course development. Primarily we must conclude that successful distance learning must be firmly based in communication and be used to enhance more traditional student-instructor interaction. Online distance learning is effective to the degree that it creates and maintains learning communities which support knowledge construction. Current online distance learning courses are too instructor driven and lack the opportunities for communication and collaboration that support genuine learning [Slavin 1980]. The creation of more collaborative tools allowing students to create and refine knowledge artifacts online is encouraging [Harasim, Calvert, & Groeneboer 1996]. Web-based communications technologies will no doubt continue to evolve to support more real time communication and a more seamless interface between communication, collaborative space and collected resources [Harasim 1990]. Flexible tools that help course designers to organize their information and incorporate communication and collaborative learning thus need to be extended beyond the current model of an HTML template for didactic presentation, toward virtual communities of practice.

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The Virtual Gallery: Exhibit Design as a Tool for Inquiry into Art, Artifact & Culture

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Abstract: The study of a culture's artistic heritage can be a source of great instructional leverage, not only to convey principles of aesthetics and of the art itself, but also as an anchor for exploring related facets of a civilization's legacy, including, *e.g.*, its religion and mythology, political structures, and societal practices. This approach is explored in the VIRTUAL GALLERY DESIGN PROJECT. Our aim is to establish a framework for historical inquiry in which students become active participants in seeking and applying new knowledge. This paper introduces an explicit instructional framework that situates learning within an exhibit design context. A student in this leaning environment assumes the role of a museum curator, engaging in historical inquiry through the process of defining an organizing theme for the exhibition and by providing commentary that elucidates the exhibit. To illustrate a specific instance of this framework, we present a prototype application in which the task is to construct a special exhibit on Women of Greek Antiquity. The approach adopted in creating the software can be formalized as an explicit architecture that can subsequently be used as a design blueprint for a specialized authoring tool to support the creation of other versions of the Virtual Gallery Design software. We conclude with a discussion of how to realize this goal.

Current Practices in History Instruction

Although the Virtual Gallery framework is applicable to a wide range of disciplines, we are targeting history instruction in our initial application. In particular, we see three specific problems in history and social studies instruction. First, the current textbook-based teaching of history creates the illusion that history is "what happened in the past," rather than being a product of scholarly interpretation. Secondly, an over-reliance on the textbook makes the historical period under study unnecessarily remote to students and deprives them of opportunities to acquire a deeper understanding of past cultures by examining the richness and detail of actual evidence. Finally, an opportunity to educate students to view artifacts as sources of information is missed.

Traditional modes of teaching history that rely exclusively on secondary accounts necessarily obscure the dimension of history as an interpretive act. If students were immersed in an environment where they were *doing* history they could engage directly in interpretive work on the surviving, necessarily fragmentary evidence of the past. *Doing* history reveals that while history is not "objective fact", neither is it arbitrary storytelling. Rather, it is based on the disciplined study of objects and texts and on the application of historical knowledge created by previous scholars. In school learning there is, typically, an imbalance, that favors learning from text, over all other sources. As a result, most members of our society do not know how to approach objects and imagery as sources of information. Specifically in the study of the past, however, there has been a traditional distinction, carried over into school History, between the discipline of History dealing primarily with "written history" and the disciplines of Art History, Archeology, and Anthropology, which are concerned primarily with the study of objects. In our research we aim to include the interpretation of objects in the general enterprise of history [Pierce 1994], by leveraging the potential of new media for the study of objects [Allen & Sterman 1990].

Rationale

The combination of artifactual and textual evidence together with secondary source material allows the student to create a more comprehensive picture of culture. The Virtual Gallery Design Project is therefore intended to teach students how to synthesize, in the form of a gallery exhibition, a coherent presentation of some significant aspect of past culture.

The pedagogy adopted in the projects aims to situate learning within a context that allows the student to apply newly-encountered knowledge to a meaningful task. The basis for such a framework lies in two general principles of learning supported by current educational theory and research: (1) Goals play a central role in learning [Ng & Bereiter 1991; Schank 1994]; (2) The learning of new knowledge is facilitated when the knowledge can be applied in an authentic context. [Brown, Collins, & Duguid 1989; Whitehead 1929]. An emphasis on pursuing a specific goal may at first seem difficult to implement in the study of the past cultures. What does "doing" mean in the context of a lesson on Ancient Greece? The Goal-Based Scenario (GBS) framework [Schank, Fano, Bell, & Jona 1994] answers this question by calling for some meaningful task environment in which to embed the teaching of content. One answer to the question "for what task is knowledge of Ancient Greece required?" is the task of designing a museum exhibition. Therefore, a plausible role for the student to assume is, in this instance, "curator of Classical Antiquities" (or rather "apprentice curator").

The curator metaphor allows the integration of artifactual and textual evidence in a goal-directed inquiry, while shifting the focus toward the images that the culture itself has left for us. Engaging the students in a goal-directed inquiry leads them to actively compare objects; look for similarities and variation in theme, style, composition and context; seek links that connect the juxtaposed material [Spiro & Jehgn 1990]; use texts to contextualize the objects and elucidate the meaning of their representation; and integrate both the textual and artifactual evidence of the past. The intent is not to teach students to be curators, but to allow them to think like curatorial scholars. The process of assembling and reassembling objects into an exhibition which makes a visually substantiable statement engages the student in composing and applying knowledge of a culture's heritage. [Fantham et al. 1994; Pierce 1994; Morris 1995].

Women of Greek Antiquity: A Virtual Gallery Demonstration

The Virtual Gallery Design Project is a general framework within which we created a demonstration application called "Women of Greek Antiquity". This somewhat controversial topic serves as well in demonstrating some of the strengths of the pedagogy that we are proposing. Views about the role of women in Greek Antiquity differ between traditional scholarship and more recent scholarship, often coming from a Women's Studies perspective [Pomeroy 1975].

In the context of "school history", where Classical Greece is often treated as the basis of modern Western Culture, the roles and status of women in Ancient Greek society are only rarely and tangentially part of the curriculum. This offers a distorted picture of history that makes women relatively invisible and that encourages gender biases by students in their study of history as well as in their views of contemporary society.

Rather than debating what is the "correct historical content that we should cover in school", however, we propose instead to use the identified debate as an opportunity to introduce students to the way of thinking by which our knowledge of the past is created. Recent scholarship that has attempted to give equal weight to texts and art [Fantham et al. 1994] suggests a picture of the role of women in antiquity that is variable, complex, often contradictory, and sometimes bizarre, defying easy answers and categorization The richness of material and the lack of easy answers in the selected topic are precisely the attributes which make for the authenticity of the task; this is the kind of topic which practicing scholars regularly address in their work.

Description of the Program

The nature and context of the student's task

Curators creating a special exhibit are in a sense composing a visual essay. They the available body of knowledge as a tool to identify within such a broad, open topic of interest, as "Women of Greek Antiquity" a dimension that they can address with an exhibit [see Pandora 1995]. They actively look through the collections in their home museum (and from other museums) for objects that are instances of the chosen dimension. They research primary texts for passages that shed light on this dimension and enhance the meaning of specific objects. They develop a structure for the exhibit which in a sense corresponds to establishing and elaborating on a "thesis" derived from available evidence of the past and reflective of their expert judgment. Finally, they select and organize the objects in the gallery space so as to convey the point of the exhibit in a coherent and engaging way. The student using the Virtual Gallery Design program will be taking up the same task.

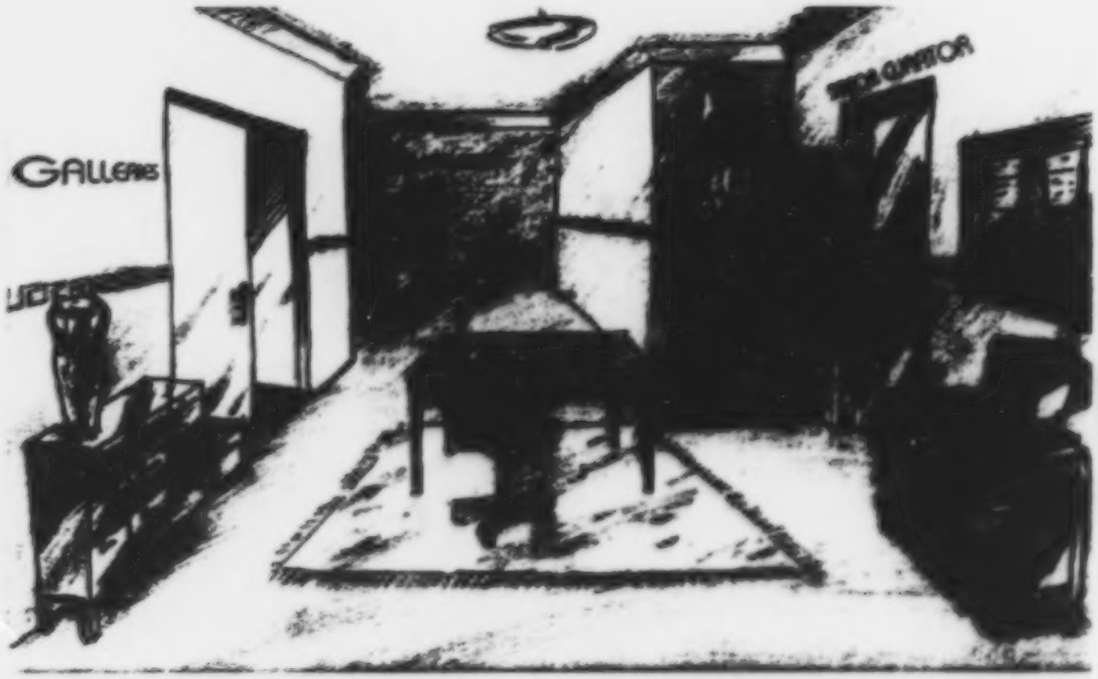

Figure 1: The Backstage Workrooms of the Museum Program Components

Immersing students in the task of constructing an exhibition is only one piece of a comprehensive learning environment. Supplying them with appropriate support resources is a second. The application provides the student with a collection of works of art , gallery spaces to populate and a virtual workspace, complete with a set of research tools to help the student in designing the exhibit. It also provides the student with expert guidance in the form of audio and video clips of a "senior curator".

Gallery space

The gallery space of the simulated museum contains the designated *special exhibit galleries*, initially empty and "closed to the public", that the student must populate with works of art. In a subsequent version we will include a ***Permanent Exhibition*** organized in the standard chronological way that will serve as a quick visual introduction to periods of Ancient Greek History and Greek Art and as a point of entry for the student who is not yet motivated to build an exhibit, but would like to browse through the program.

Research Tools

The research tools available to the student are organized around the metaphor of "backstage workrooms" in the museum [Fig. 1]. The *research desk* [Fig. 2] contains structured forms that help guide students' exploration of the works of art by prescribing a set of subtasks to be pursued: articulating an exhibit topic and structure, labeling the gallery spaces to reflect the selected topic and structure, grouping together objects and assigning them to parts of the exhibit. A structured notebook is provided for the student to record research notes and inferences as well as design ideas. Templates are provided to compose descriptive essays accompanying each object and "wall text" introducing the galleries to the visitors. The structure of the research room is intended to reinforce the idea of an exhibit as a "visual essay" and to guide the student in marshaling her arguments. It also scaffolds the student in successfully managing a complex task that might otherwise prove overwhelming.

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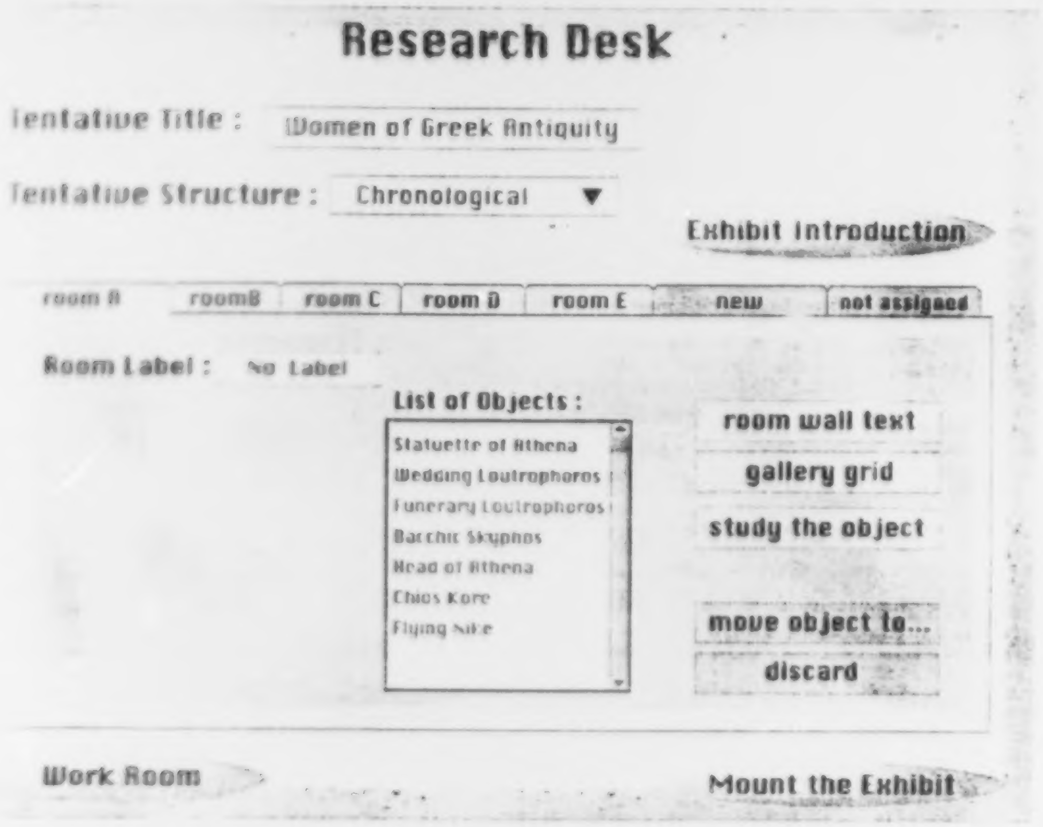
Research Desk

Tentative Title : Women of Greek Antiquity

Tentative Structure : Chronological

Room Label : No Label

List of Objects :
- Statuette of Athena
- Wedding Loutrophoros
- Funerary Loutrophoros
- Bacchic Skyphos
- Head of Athena
- Chios Kore
- Flying Nike

Figure 2: The Research Desk for the learner as "Apprentice Curator"

The searchable photo-archive catalog displays a picture of the object together with basic archival information and short curatorial notes. It is as a research tool that allows the students not only to browse the collection but to locate objects relevant to the topic that they are pursuing, through categorical searches by label, date, material, location found, origin, and curatorial note. The action of "ordering photos from the archives" serves as a metaphor for selecting an object for study.

The basement is where full size, high resolution images of the objects are displayed. It is the place where the student goes to browse and closely examine an object. The basement serves in focusing the student on studying individual works of art without the distraction caused by the presence of interface elements and text. Of course, the basement metaphor is also meant to evoke a sense of curiosity, important for exploration.

The gallery grid is a tool that allows the student to design the spatial layout of the exhibit, prior to "mounting it" (i.e., sending the objects to the gallery space). It presents a layout of the gallery in which the student can arrange objects by dragging them.

Expert Guidance

Expert support, in the form of advice and commentary, is designed to provide task guidance to the student. The "expert", in this program is a "Senior Curator of Classical Antiquities". The guide's role to advise the student on possible strategies to try next, or places in the program that might be useful to visit at the current point in the interaction. The "Senior Curator" initially appears on video to explain the student's mission. The description of the student's mission is available to the student throughout in written form through a bulletin board labeled "Notes from the senior curator".

The "Senior Curator" appears on video, subsequently, at the student's request. The student can "ask" the expert questions such as the following:

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What is a Special Exhibit?
What exhibit structures are possible?
How do I study an object?
How do I choose objects for the exhibit?
How do I decide on my exhibit structure?
What should each room introduction include?
What should I write in an object description?
What should the exhibit introduction include?

The menu of questions that is available to the student in each interaction with the "Senior Curator" is context sensitive. Sound bites of the expert also accompany the student in her exploration of the basement, where appropriate, for example to direct the student's attention to an object or a part of an object that is particularly important; to relate a myth or fable to an object.

Subsequent versions will include additional expertise in the program in the form of videotaped interviews with curators, art historians, archeologists, anthropologists and historians. The content of these interviews will be indexed into brief segments according to the questions answered and raised by the remarks in that segment.

Content Material

The collection of content material will eventually include a collection of objects, texts, secondary sources and a stock of exemplar exhibit topics. The *collection of objects, complete with archival information* currently includes 60 objects of Ancient Greek Art selected to exemplify as exhaustively as possible the range of representations relevant to women. The collection includes painted vases, pedimental sculpture, relief sculpture and free standing statues in marble, bronze, and terra-cotta and repousse metal work. The program indexes these objects in ways that encourage students to make meaningful conceptual links among the material, in particular (1) by browsing the objects (we use the metaphor of "walking through the basement" of the museum); and (2) through a searchable "photo-archive catalog". In future versions we also plan to link each work of art in the collection with comparable objects.

The following content components although not yet implemented in the current version are part of our conception of the workspace as a structured task environment. *The body of selected excerpts of primary texts* will be indexed based on the objects to which they have relevance. The purpose of the collection of primary texts is to enhance the student's ability to study an object by helping her to identify elements of the representation (e.g., the identity of objects, human figures), to discover the meaning of a scene, or to notice a detail in the composition. Further, texts add to the broader context of interpretation offering insight into the ideas, conditions and concerns of the society that created the art. Finally, the texts may serve as quotes for the student's gallery texts.

A set of abridged general reference material on Ancient History and Art serves two purposes: as a quick overview of Greek History when needed; and for easy access to basic information that is instrumental to the task at hand. In this sense our reference material redefines the role of the traditional textbook, by turning it into a cognitive tool in the service of purposeful inquiry.

A set of exhibit design ideas accessible to the student through the "Curatorial Resources Cabinet" offer an alternative venue for approaching the task at hand. This venue provides the student with a number of exemplars demonstrating possible ways to structure an exhibit, according to accepted principles of exhibit design (chronological, geographical, by medium, thematic, etc.). The purpose of these examples is, first, to provide a more structured approach to the task for the students who desire it, thus avoiding the frustration of unstructured exploration, and, second, to serve as a resource for comparing, evaluating and refining ideas for all students.

Future Work

The Virtual Gallery Design Project helps a student to view the material remains of the past from a perspective that typically lies within the sole grasp of the scholar. With the Virtual Gallery Design application, middle-school and lower-level high-school students will be able to construct their own exhibitions around the topic "Women of Ancient Greece" thus developing and applying knowledge of History, Art History, and Archeology in authentic ways.

A broader aim of this research, however, is to develop a widely applicable paradigm that will facilitate the construction of other, related applications. The aim is to ultimately make the construction of other Virtual Gallery Design applications a task that demands knowledge of the target domain but requires little computer expertise. A specialized Virtual Gallery Builder tool will allow domain experts and instructional designers to readily create new instances of the Virtual Gallery. For instance, a "Decorative Arts of 18th Century Europe" Virtual Gallery could be created by adopting broadly similar architecture but replacing the Greek content in the original software with a new set of materials. This architecture, though, reaches beyond the study of material culture of the past. It could be used in a science and society curriculum, for example wherein the students create their own AIDS education exhibits for a virtual science museum; or a teacher developing a Peace Studies curriculum might used this tool to support students in constructing exhibits in tribute to victims of genocide. The specifics of what each such application might teach can vary widely; what all applications will share will be their underlying pedagogy.

Conclusion

The Virtual Gallery Design Project seeks to create a learning environment in which the task of exhibit design is used as a window into historical inquiry. This goal-based approach to instruction is particularly suited for the study of history and social studies because: (1) it brings the student into contact with both artifactual and written evidence, the two sources of information about the ancient past, and engages the student in thinking both with images and with text; (2) it creates a simulated task within which these primary sources can be authentically combined with more traditional aspects of teaching such as textbooks (used as cognitive tools) and direct instruction; and (3) it authentically incorporates the goal of synthesizing evidence into a coherent account or argument, presented both visually and in text, in the form of a completed exhibit. A study of the roles of women in antiquity is only one instance of a Virtual Gallery Design environment. Of greater significance is the more general approach to instruction that it demonstrates. The Virtual Gallery Design Project will yield an architecture that can guide the development of subsequent computer-based learning environments.

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Wx-Brief: Aviation Forecasting as Earth Science Inquiry

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Abstract: Data Analysis for Understanding Global Systems (DAUGS) is an instructional model under development that engages the learner in formulating predictions within a simulated task environment. Part of this research is the development of an exemplar application called *Wx-Brief.* [1] This simulation-based learn-by-doing environment teaches secondary science students about the causes and behaviors of atmospheric phenomena. A student using the software assumes the role of a weather briefer who must respond to pilot requests for weather conditions likely to prevail during a particular flight. In this paper we introduce Wx-Brief and include a sample interaction that illustrates some of the features of the application. We then explain the DAUGS model of which Wx-Brief is an instance. We conclude with a discussion of how our instructional approach may be applied in combining simulation with real-time information.

Wx-Brief: An Exemplar Application

We are developing an application, *Wx-Brief*, to both serve as an instance of a proposed instructional model, Data Analysis for Understanding Global Systems (DAUGS), and help guide its definition. The application was selected on the basis of its merit as a standalone research project and as a potentially important adjunct to current classroom practice.

Motivation

Study of atmospheric phenomena illustrates some of the limitations of traditional instruction. The factors influencing weather are numerous and complex, but conventional science classrooms offer little opportunity to explore these interrelated phenomena within some meaningful task environment. Predicting the weather, for instance (routinely employed by advocates of hands-on science), is a step toward in-situ inquiry, but demands only an understanding of how various instrument readings correspond to likely changes in weather patterns, without requiring a deeper understanding of the causes of such changes.

Description

Wx-Brief is a program aimed at addressing these difficulties. A learner using this software assumes the role of a forecaster who assists pilots in preflight planning by synthesizing a forecast tailored to the pilot's proposed flight path and departure time. In the course of preparing the weather briefing, the learner will develop an understanding of the forces governing weather patterns. Instruction in the Wx-Brief application will be organized as a set of modules, each focusing on a visible weather phenomenon that will serve to anchor inquiry into a related set of concepts. Our initial efforts are focused on developing an instructional module centered around thunderstorms; we will subsequently develop precipitation, wind and fog modules. In carrying out the task of providing pilots with pre-flight briefings, the learner will for each phenomenon acquire the skills involved in predicting it and explaining the conditions required for its formation, identifying it from observations and weather products, accounting for its present behavior, and projecting future behaviors. Each module thus represents an analog to a chapter or unit in traditional Earth Science classrooms [Tab. 1].

Interaction Synopsis

The software consists of three parts: the interface, which sets the context, presents the available resources, and maintains the results gathered by the student [Fig. 1]; a database of reports and maps relevant to each scenario; and expert guides (meteorologist and weather briefer) to answer questions likely to arise. In a typical interaction, the student is first presented with a weather briefing situation and then encouraged to analyze reports and maps in order to construct the requested briefing. The software guides the student's investigation into the connections and causal relationships among various weather phenomena. The student ultimately provides a summary of his or her findings in the form of a briefing to the pilot. Once the learner submits the briefing, he or she sees a briefing that an actual weather briefer prepared for the corresponding flight, and can then examine actual conditions that prevailed and how closely they matched those forecast. Differences between forecast and actual conditions then serve as focal points for continued inquiry.

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[1] The title of the application comes from the telephone number adopted by convention by the regional Flight Service Stations providing pilot weather briefings, 800-Wx-Brief.

	Instructional Goals	**Target Concepts**	**Scenario**
Thunderstorm	predict it explain the conditions required for its formation identify it from observations and weather products account for its present behavior project future behaviors	water vapor, stability, condensation, cumulonimbus cloud, fronts, air masses, squall lines, hail, lightning, thunder	pilot requests outlook briefing for flight plan that could encounter severe systems.
Precipitation	predict it explain the conditions required for its formation identify it from observations and weather products account for its present behavior project future behaviors identify types of clouds relate weather to cloud types	water cycle (condensation, evaporation, precipitation), fronts, relative humidity, saturation, dew point	pilot requests routing that would remain clear of precipitation
Wind	predict it explain the conditions required for its formation identify it from observations and weather products account for its present behavior project future behaviors identify prevailing wind patterns in various regions associate wind with other phenomena	radiation, heat, temperature, pressure, absolute and relative humidity, Coriolis effect, convection, jet stream	pilot requests forecast turbulence along route of flight

Table 1: Initial modules comprising the Wx-Brief application

Example: Thunderstorm module

We use the Thunderstorm module to illustrate some of the interaction between user and system. The opening segment includes an introduction in which the Supervisor says, "Welcome to New York Flight Service. When your shift comes on you'll be answering calls from pilots. They'll be giving you their flight plans and you'll need to give them weather information. Do your best to interpret the data from the weather products on your console and help the pilot make an informed decision." At this point, the learner can take a "call" from a pilot requesting a briefing such as, "Tail number 666 Whiskey X-Ray, departing Albany at 3:30 local time direct to Islip. VFR at 3500 feet, and will be approximately 1 hour and 15 minutes en route," [Fig. 2]. The audio is complemented by an annotated transcription that maps the pilot's request onto the parameters needed by the student, *e.g.* the time of departure and the proposed route. Once the learner takes a call he or she sets out to construct a briefing similar to those provided by FAA specialists. The elements of a standard weather briefing include adverse conditions that might suggest alteration or cancellation of a proposed flight (such as a thunderstorm, icing, or severe turbulence); a synopsis as to the cause of the weather (*e.g.*, fronts or pressure systems); current conditions; en route forecast; and destination forecast.

The students would then proceed to gather data relevant to the pilot's request from an array of weather products such as surface weather reports, terminal forecasts, weather depiction charts, radar summary charts, and significant weather advisories. Associated with each of these maps and reports will be explanations of how each should be interpreted and supplementary advice, such as potential ambiguities arising from a particular source of information [Fig. 3]. In the example case, the weather depiction chart might indicate that a cold front is approaching the destination; the student would be given hints to point out the possibility of a frontal thunderstorm. Since the issue at hand is whether this represents a threat to the pilot's proposed flight, the main concern is whether a thunderstorm will develop, and if so, whether it will be a factor along the proposed route. In the student's investigation, he or she has access to a number of predictive sources that might suggest that a storm is likely to develop. Suppose, though, that no thunderstorm activity is being reported by any surface observation stations or by pilots en-route. How should the student reconcile the forecasts with the observations?

The program might suggest at this point that the student consult satellite imagery, for instance, which would show evidence of building towering cumulus clouds (the progenitors of cumulonimbus or thunderstorms) along and ahead of the front [Fig. 4]; returned echoes on the radar imagery could indicate regions where precipitation is forming within young thunderstorms. Having now identified an adverse condition and its cause, the student would proceed to apply his or her new understanding of frontal systems into the emerging briefing.

Once the learner delivers the briefing and makes a recommendation, the program provides feedback on the student's performance, including the (simulated) results of the pilot following the student's recommendation, a briefing (for the same flight) prepared by an actual briefer, an explanation of how this specialist constructed his or her briefing, and the (real) weather conditions that obtained during the (simulated) flight.

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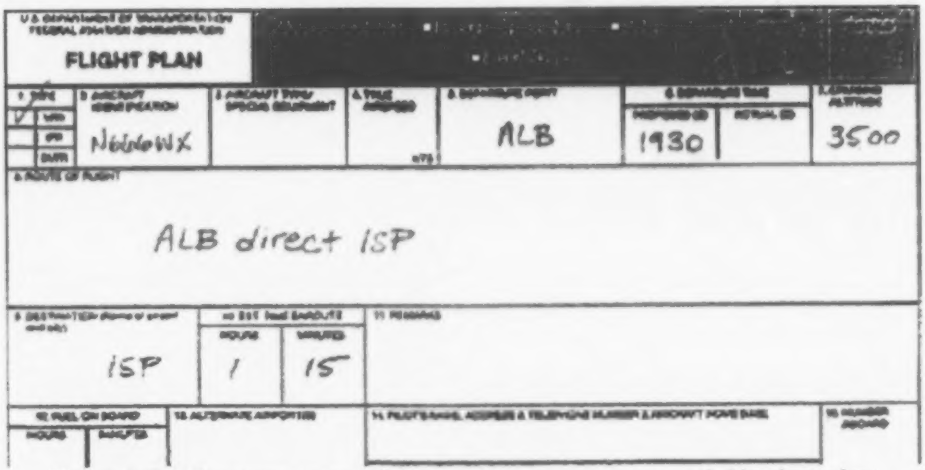
Figure 1: Initial Interface Display: The Briefer's Console



FLIGHT PLAN

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Figure 2: Briefing request maps pilot's request onto parameters needed by the student.

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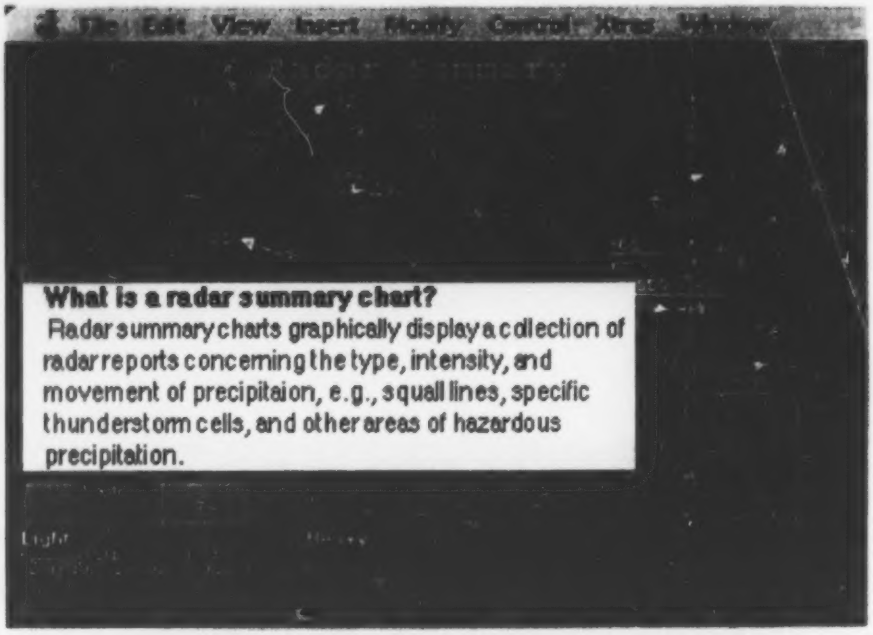

What is a radar summary chart?

Radar summary charts graphically display a collection of radar reports concerning the type, intensity, and movement of precipitaion, e.g., squall lines, specific thunderstorm cells, and other areas of hazardous precipitation.

Figure 3: Associated with each map are guides to interpretation.

Building Understanding from Analysis and Synthesis Tasks

Wx-Brief is intended in part to illustrate an instance of a model called Data Analysis for Understanding Global Systems (DAUGS) that integrates content-domain knowledge, software simulation, data visualization software, and real time Internet data.[2] The model calls for the learner to prepare a set of predictions (*e.g.*, a briefing or recommendation) for agents in various situations who are dependent on the accuracy of the learner's predictions. The model is intended to be applicable, at a minimum, to Earth Science instruction at the middle and high school level, though it is likely to have broader utility.

DAUGS model as a framework for Earth Science Inquiry

"Understanding Global Systems" reflects our emphasis on a systems approach to Earth Science, which we have selected as our target domain for two reasons. First, Earth Science is a reasonable anchor from which applications in other domains could be created, since the scientific methods of inquiry and theory-building emphasized in the proposed model are important and broadly-applicable cognitive strategies. Second, Earth Science is an inherently accessible and understandable area of science [Kastens 1995]. "Data Analysis" suggests our focus on engaging students in the inquiry process, which enjoys broad support [Dewey 1938; Gagne 1977], and has been noted in particular in the realm of science instruction [Brown, Collins, & Harris 1978; Simon 1977; Tweney, Doherty, & Mynatt 1981].

Related instructional frameworks

The DAUGS model has roots in two general frameworks: Goal-Based Scenarios (GBS) and Interpretation Construction (ICon). *Goal-Based Scenarios* [Schank, Fano, Bell, & Jona 1994] offers a general structure for learning-by-doing, simulation-based educational software. The GBS framework calls for placing the student in a role in which the target skills and knowledge will be encountered during the course of pursuing some goal relevant to the student's role. Interpretation Construction [Black & McClintock 1996] is a model that calls for students to learn about a topic by making basic observations (raw data collection), then constructing interpretations of those observations while accessing multiple background materials and being coached by a teacher expert in the topic area. Empirical studies have provided preliminary support for both the GBS [Bell, Bareiss, & Beckwith 1994] and ICon [Black, McClintock & Hill 1994] frameworks.

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[2] The Wx-Brief application is designed to accommodate the use of real-time data but this element of the software has not been implemented.

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Figure 4: Secondary materials foster comprehension of thunderstorm formation factors.

Using the model to appropriately constrain and sequence content

The mere availability of technological resources that might support a Goal-Based pedagogy does not, in and of itself, yield any clear instructional design principles, and it is at the level of instructional design that teachers and researchers have had some difficulty translating emerging potentiality into effective classroom practice. We offer that the dominant design problem for educational scenarios that are goal-based and premised on interpretation construction is the proper constraint of the learning environment.

[Swan & Black 1993], [Harel & Papert 1991], and [Kafai 1995] have all demonstrated, in the context of teaching programming fundamentals and problem solving techniques through Logo, that a carefully constrained learning environment results in far more acquisition than a largely unconstrained, open-ended exploration. Similarly, [Riesbeck 1996] has argued that goal-based scenarios that provide powerful tools but little other formal instruction or modeling are akin to the teaching of carpentry by providing a learner lumber, saw, hammer, nails but no carpenter to whom to apprentice. The DAUGS model casts learning in part as an act of pattern recognition. The experienced scholar or professional is able to identify patterns in complex data, discriminating between relevant feature and "noise". Recognizing relevancy and filtering out noise requires experience with a broad range of cases that attune one to essential characteristics [Gibson 1977; Greeno & Moore 1993; Greeno 1989; Lave 1988; Suchman 1987].

For a student of Earth's environmental systems, relevant patterns may be difficult to recognize because instances of a category may be idiosyncratic and, in ways not germane to interpretation, diverse. Most cold fronts, for example, are accompanied by cooler air, but often during summer months they are instead accompanied by warmer air; relative to their effects on wind and dew point, for instance, this diversity is irrelevant and both cases are properly recognized as cold fronts. This type of complexity in a knowledge domain has been discussed as its "ill-structuredness" [Spiro et al. 1991]. In a convincing analysis of expertise, Spiro et. al. have described experts' appreciation of ill-structuredness as a result of having "criss-crossed" the landscape of a knowledge domain to such an extent that family resemblance among cases is recognized amid all the idiosyncrasy. The DAUGS model is designed to enable learners to work with data in a way that attunes them to the knowledge domain's complex structure.

Conclusion

Our discussion of Wx-Brief serves both to present an engaging and instructionally meaningful learning environment, and to demonstrate the application of an instructional model. The interaction between the student (as weather briefer) and the (computer-controlled) pilot situates the task of understanding weather within a compelling task context, and illustrates not only a set of principles but their utility as well. The underlying model, Data Analysis for Understanding Global Systems, prescribes a task environment in which the learner engages in formulating a recommendation based on inferences drawn from available data.

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One aspect of the model absent in the demonstration application is the use of real-time information. Simulated environments such as Wx-Brief use simplified data to provide clear opportunities for concept formation, engaging students in the process of learning by doing. In contrast, access to real data sources provides authentic opportunities for outcomes prediction in evolving situations, offering a field for the application of concepts attained through goal-based simulations and other concept-formation activity. Although each technology has particular strengths, little work has been done to systematize how they may be applied in concert to the best instructional advantage. Two aims of the DAUGS model, and the applications it shall inspire, are to exemplify the appropriate use of simulated versus real contexts for scientific study, and to introduce teachers to classroom simulations combined with real data access as a powerful strategy for science learning.

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Teletesting: Design and Implementation Issues

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Abstract: Evaluation is integral to most educational designs. As such, teletesting is evolving into a key component of computer-based distance learning systems. Teletesting promises a number of advantages over local or fixed-site testing, including cost and time savings for participants, as well as increased flexibility. However, there are a number of issues related to teletesting systems that are often of less importance in systems designed for only content delivery. These issues, which may be related to the increased significance of test results, include: privacy; environmental consistency; legal concerns; security; hardware platforms; cheating; network infrastructure and bandwidth; image transfer and display capacity; test generation location and method; distribution media; and testing design.

INTRODUCTION

Testing is an integral component of learning, whether this learning is accomplished through conventional, local computer-based, or distance learning environments. Testing can be an obviously separate component of a computer-based learning experience, or an integrated component of the pedagogical design, such as when a gaming approach is used [Bergeron and Fallon 1990]. Computer-based testing of all forms is gaining popularity in a number of areas. Not only are SAT, GRE, and private pilot examinations now offered via computer, but computer-based testing becoming an important option for many professionals seeking competence assessment [Friedman 1986] as well as licensure and recertification [Clyman 1990; Sumner and Truszzynski 1995].

Unlike self-examinations and other testing options used primarily as an aid to self-study, many computer-based tests now hold considerable weight. That is, there are increasingly instances when the consequences of testing, and therefore the pressure to score well, are great. In medicine, for example, a number of medical boards are actively pursuing teletesting alternatives to the current practice of on-site oral and written exams for recertification. The pressure to pass these examination once every 3 to 5 years is enormous. For example, some medical board exams are currently offered only once per year; failure to pass these oral and written examinations precludes practicing medicine until the next exam. Currently, heavily monitored recertification examinations are subject to challenges by those failing to pass examinations. Obviously, any aberration from a perfect, standardized testing environment that can be identified by someone failing to pass an examination will be used in their defense.

In part because of the weight placed on the associated results, teletesting system requirements can be very different from those used strictly for delivering instructional materials over a distance. Some of the more significant issues in teletesting include: privacy; environmental consistency; legal concerns; security; hardware platforms; cheating; network infrastructure and bandwidth; image transfer and display capacity; test generation location and method; distribution media; and testing design. As outlined below, many of these issues can be attributed to the bi-directional data flow requirements associated with program instrumentation [Bergeron 1990], the potential variability in testing environments, and the need to guarantee the security and accuracy of the testing content, the testing process, and test results.

Teletesting Issues

Many of the issues relevant to teletesting pertain equally to any testing situation: the need for privacy, a constant, repeatable testing environment, security for testing materials and to insure valid test results (i.e., no cheating), and adequate help when it's needed. Other issues relate directly to computer-based testing, such as hardware adequacy and consistency, the suitability of the network infrastructure (if applicable), test content generation and validation, the distribution media, and the validity of the overall computer-based testing approach. The main issues and possible solutions are described in more detail below:

Environmental Consistency

For test results to be valid, the testing environment, which encompasses not only what the user experiences on the computer, but also the ambient noise, glare, potential distractions, and creature comforts. Everything from the relative humidity, temperature, time of day, chair comfort, video display height, and provision for left- or right-handedness defines the testing environment. If users are to be scored relative to one another (as is normally the case), the teletesting environments should be as identical as possible in these and other parameters, in fitting with the significance of the test results. Possible solutions include: establishing and enforcing standard hardware configurations (e.g., 17" monitor, 200 MHz Pentium processor, 56K Modem), including calibrated monitors and sound equipment.

Privacy

Related to environmental consistency, users normally expect a degree of privacy or at least freedom from distractions. Privacy may mean very little to someone in an engineering firm involved in a self-study program on their free time, but may be of paramount importance to a physician taking a six hour recertification examination remotely. In high-visibility teletesting situations, such as a when results impact directly on licensure, privacy may be insured by providing dedicated testing areas. However, remote testing centers are generally an expensive option, especially if no other use for the centers is planned. Reasonable solutions include: use of partitioned computer testing areas (e.g., a school's computer learning resource center), restricting the use of voice recognition interfaces, and appropriate visual barriers between computer stations.

Security

Unlike a proctored computer-based examination, where one or more trained examiners are available to observe any unusual behavior on the part of the test takers, teletesting must rely upon trust and, increasingly, technology. For example, just as floppy discs and even CD-ROMs can be copied, content and questions delivered the WWW or other network can be easily captured and redistributed. Unforeseen circumstances, such as unexplainable, sudden power outages or unexplainable computer failures can also be provided for somewhat by relying on network-based teletesting. For example, someone unhappy with their current score could potentially unplug their computer, make several duplicates of the distribution floppy to access "practice" examinations, or somehow decipher how the test score and tracking data are recorded and create a falsely inflated record.

When test content is distributed via a network, however, attempts at breaking security checks can be limited. It is possible, for example, upon computer failure to either refuse a retest at a distant site or to simply regenerate another exam, completely different from the first. This is possible with remote storage and generation of exam content. Such an approach, however, makes certain assumptions about the stability and performance of the hardware platform and network bandwidth. Alternatively, a remotely-activated digital camera, directed at the user, can be used to randomly record frames of the user interacting with the testing system. Such remote monitoring may be sufficient to inhibit the use of unsanctioned support materials or hardware tampering.

Validation

Related somewhat to security and environmental consistency, validation of the remotely administered test must somehow encompass how well the test measures what is intended to be measured. Compared to traditional computer-based testing, where many of the environmental and hardware factors can be held constant, determining the validity of a teletesting scenario can be challenging. For example, in an image-intensive test requiring on-screen display of medical radiographic or photomicrograph images, variations in monitor size, dot pitch, phosphor composition, refresh rate, or even contrast setting can mask or enhance significant image features. Similarly, a trackball on one system might give the user an unfair advantage or disadvantage compared to someone using a system with a mouse or light-pen. Ideally, the test scores should be minimally influenced by the user's proficiency with specific hardware. To this end, evaluation techniques, such as control groups, management objectives, regression analysis, case analysis, and cost-based analysis can be used in assessing the validity of a specific teletesting application [Moad 1995]. Other solutions include adhering to a standard user environment, as discussed above, and heavy reliance upon program instrumentation techniques.

Legality

Given the significance of some teletesting results, it can be expected that people who fail to achieve passing scores will challenge the system. For example, in medical recertification examinations given orally or in controlled written test situations, physicians who fail these tests routinely challenge the medical board on the validity of their assessment tools. Given that teletesting is in large part unproved, legal challenges can be expected to increase before teletesting becomes an accepted reality. Tentative solutions include: thorough program instrumentation so that specific cases can be regenerated for expert analysis if need be; comparative studies relating performance on locally administered versus remotely administered examinations; and a through validation of the overall teletesting strategy.

Hardware

In the context of this discussion, teletesting is totally dependent upon a computer system capable of providing images, video, text, or other content as appropriate for testing purposes, as well as a means of capturing and processing user interactions with the testing software. The hardware platform and associated supporting infrastructure define the upper limits of fidelity and overall capability of the testing system. For example, multimedia-rich applications may minimally require high-fidelity audio playback hardware and associated speakers, video playback hardware capable of real-time 3D rendering and video decompression, and a high-throughput CD-ROM drive. A hybrid or WWW-based system may additionally require a high-speed modem or the appropriate Ethernet hardware. As described above, the solution to the hardware dilemma seems to be linked to establishing a standard testing platform.

Network Infrastructure

Despite the exponential growth in WWW capabilities and popularity, the network infrastructure has quickly become the limiting factor in remote testing and education delivery. Although there are currently significant security and bandwidth limitations, the WWW is quickly evolving into THE standard means of delivering educational materials. Even when teletesting is based on programs distributed by CD-ROM or floppy, network connectivity can be used as the basis for communicating program instrumentation data back to a central, secure repository. This method of data collection can be expected to rapidly replace the current practice of requiring users to mail floppies to a facility where the tracking files can be examined and scored. Issues surrounding network infrastructure should be resolved with the increased bandwidth and connectivity promised by constantly evolving network architectures.

Distribution Media

The hardware platform and network infrastructure, together with marketing, demographic, and economic issues, define the optimum distribution media for teletesting applications. For example, high-speed Internet connectivity, although commonplace in academic institutions, has yet to become the norm in many isolated communities that could benefit the most from telelearning and teletesting. Similarly, although virtually all PC's sold today come with CD-ROM drives as standard equipment, new, high-end PC's tend to be rare in remote, rural areas. Distribution on inexpensive floppies limits the teletesting environment to predominantly text, with few graphic embellishments. Obviously, the distribution media of choice can be expected to evolve rapidly to hybrid CD-ROMs and the Internet. The issue of distribution media may well be solved on its own as bandwidth increases, and as distribution relies on multiple avenues of delivery.

Content Generation

Perhaps the most resource intensive component of any teletesting system (or local testing system, for that matter) is that of content generation. The difficulty associated with creating a library of images and associated questions, together with a valid answer pool, is related to the many of the issues described above. For example, if security is lax, a larger library of content is required, so that multiple tests can be generated with minimal duplication. Similarly, if great cost is incurred in creating content, such as in rather lengthily medical recertification examinations, then some automated means of content generation may be optimal. However, automatic generation of content, especially if this generation occurs at the user's site, presents several validation challenges. Exhaustive program instrumentation can help identify any aberrations in such content, but this has its own security and hardware platform issues. For the short-term, the best solutions seem to revolve around remote content generation, and extensive libraries of images, sounds, video, and text, e.g., institution- or corporation-wide multimedia libraries.

Summary

Teletesting is quickly becoming an integral component of distance learning. Proper attention to the issues discussed above, especially those pertaining to potential abuses by unscrupulous users and provision for consistent hardware and network infrastructure will help insure the viability of teletesting. The ultimate success of teletesting rests on the ability of those involved in the larger computer-based testing field to perfect and validate the medium.

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The Co-operative Peer Response System: CPR for Students

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Abstract: With ever present financial and human resource constraints, universities must find innovative ways to preserve the standard of education students receive, given the limited help resources presently affordable. One way to achieve this is to utilize technology in providing individualized help. This paper focuses on the design of the Co-operative Peer Response ("CPR for students") project - a system that seeks to address these issues. The rationale and context of the project and a preliminary evaluation of the system are also provided.

1. Introduction

This paper presents the Co-operative Peer Response ("CPR for students") project and provides the rationale and context for the project. The problem that is being addressed is the effective distribution and utilization of help resources in a university course setting. As University budgets are under constant pressure and class sizes continue to grow, new ways must be found to preserve the quality of education received by students. One way to do this is to utilize technology in providing individualized help.

Students generally only seek help just prior to major academic deadlines. This surge in help requests is compounded by the fact that there is a wide disparity in the nature of the help and the manner in which help is solicited. Some students are bold enough to request help during lectures or tutorial sessions. Others will only consult the instructor in a private setting. A large majority of students will rarely ever ask instructors for assistance, preferring to ask classmates and peers. Student study habits also hinder the effectiveness of traditional help resources. Since help is generally available during traditional working hours and many students work nocturnally, the available help is not utilized effectively. Due to financial cutbacks, lecturers and laboratory assistants may become overwhelmed with help requests, many of which are variations of the same questions that could easily be answered by the peers of the help requester.

The main objectives of the Co-operative Peer Response system are to capitalize on a generally underutilized, but nevertheless important resource: the students themselves. In doing so, this modified Web-based Frequently Asked Question (FAQ) system will also meet the following sub-objectives: to provide help specific to a particular class context; to identify and use the expertise of class "gurus" (local experts); to accommodate both public and anonymous help givers/seekers; to get a better understanding of how help resources are utilized, and to get a more accurate assessment of the problems students find most difficult in the course.

2. Present Help Resources

Existing help facilities in university courses fall into three broad categories: printed material, human to human interaction, and electronic support [Jenssen 93]. Printed help material is produced in one central location and is uniformly presented to the students. However this may be a costly or inefficient method of dissemination.

Human help resources such as instructors, laboratory assistants and tutorial leaders are expensive and heavily loaded. There is also a generally unacknowledged, but important, help resource in most courses: peer experts, who invariably help many of their fellow students with assignments [Bannon 86]. Human help makes it easier to identify exceptional students, in turn leading to a more accurate method for evaluating students and assessing their problem areas.

Help Desks (such as telephone help desks) are not generally deployed in particular courses, but rather on an institution-wide scale, especially for technical questions. This method of help support, though serving many users, is not a mass help medium like an FAQ, as the type of user interaction is personal and a great deal of the time is spent repeatedly answering the same questions and establishing the context of the problem. Help desks are generally used as a last resort when no local expert is available to answer the question.

Enrollment increases in university classes have made human help and print resources inadequate or infeasible. Electronic tools provide a relatively cheap means to augment help resources. These tools includes newsgroups, electronic mail, mailing list servers, the World Wide Web, groupware, computer conferencing software, and electronic help desk support.

Electronic mail (email) and mailing lists (listservs) are popular at universities. However, since everyone in the group can contribute their ideas, in a large listserv, sorting and organizing the messages is an arduous task placed on the group member. A large load is also placed on hardware resources as there are usually many copies of the same email documents stored.

Newsgroups, like listservs, include the viewpoints of many users leading to a better overall discussion, without the same intrusion and excessive usage of hardware resources. Newsgroups give the possibility of incorporating many types of Internet resources (ftp, gopher and Web sites). The ability to thread and organize the information that subscribers (newsgroup users) submit and view is yet another advantage. Organizational responsibilities for newsgroups fall on the moderator rather than the subscriber. Important postings can be archived for future use. The immediate nature of a newsgroup posting means that instantaneous responses to queries will occur. The main problem that most newsgroups face is their lack of use, due primarily to the more glamorous communication alternatives (e.g. the Web, groupware, and computer conferencing) available.

The Web can disseminate help material of a textual, visual and aural nature, reducing the cost of printing. Updates are easily done. The Web, through the use of conferencing applications like WWWBoard [WWWBoard 96] and NetForum [NetForum 96], can offer the same services that newsgroups provide.

In most departments, the primary use of the Web as a help tool is with lists of Frequently Asked Questions (FAQs). FAQs are useful only if sufficiently populated with up-to-date questions and answers, and the help requester is able to properly formulate queries and find answers that exist somewhere in the list. FAQs are ineffective if the question has never been asked before. The maintenance and organization of FAQs, as well as answering user queries is usually done by an expert (the moderator). Unlike a newsgroup, little use is made of the latent pool of knowledge that the users' peers possess. Some FAQs allow peers to answer the queries of other users, but these are the exception rather than the norm.

Lotus Notes [Notes 96], and Microsoft NetMeeting [NetMeeting 96] are popular commercial groupware and/or conferencing packages, but they place hardware and financial constraints on the institutions that use them. Some applications such as Motet [Motet 96] have database support which aids in the organization and customization of material presented. These products are not usually tailored to the specific needs of university courses.

WebCT [WebCT 97] makes it easier to create web pages, monitor user accesses and evaluate students. It supports email, newsgroups and chat facilities. However it has no real database support and this limits the additional benefits that should be derived from an application of this nature. For example user modeling, customization, information filtering and a good search engine are difficult to implement, since a detailed knowledge of the internal representation of the data stored is necessary.

All of these methods of providing help have their own strengths and weaknesses. Some can cater to several types and numbers of users, while others are limited in their potential use. The more personal forms of communication such as email and telephone help desks can be used by the "anonymous" help seeker but in this method the group generally does not benefit from the interaction.

3. The Design of "CPR for Students"

The CPR Project is an attempt to capitalize on the strengths of the current support tools, while minimizing their weaknesses. The Co-operative Peer Response System provides the following: a newsgroup-like facility where students can post questions or comments; an interface to support rapid responses from peers, tutors, or instructors; an accounting system to recognize students who provide and use peer help; an FAQ facility; tools to aid the moderator in constructing and organizing the FAQ, and a database of potential peer helpers. The system is customizable to a particular course, providing peer help and FAQ facilities via the Web. [Fig. 1] gives a conceptual representation of the CPR architecture.

At the core of the CPR system is the extensive use of a database [Fig. 1]. The database tracks interactions between the user and the system, is used to create and maintain web pages, and keeps a profile of each user. To keep the posted material relevant to the particular class, access to the system is restricted to registered users. CPR uses only standard HTML tags on all of the pages, and is therefore accessible to both textual and graphical browsers. The system has two sources of help information available: a rapid response area, called the Recent Questions and Answers page, and an archived section called the Moderated FAQ.

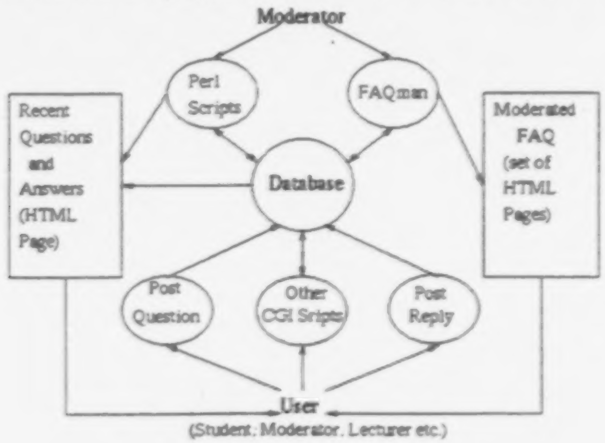

Moderator
Perl Scripts
FAQman
Recent Questions and Answers (HTML Page)
Database
Moderated FAQ (set of HTML Pages)
Post Question
Other CGI Sripts
Post Reply
User
(Student; Moderator, Lecturer etc.)

Figure 1: The CPR system architecture

3.1 Recent Questions and Answers Page

The presentation and function of the Recent Questions and Answers page is similar to a newsgroup, with the content provided by the users themselves. Links to the latest questions and their associated replies are stored on this one HTML page, which is used to organize and index the information found in each separate question file. The most recent questions are placed at the top of the page, and the most recent replies to a particular question are placed at the top of that particular list of replies. This threaded scheme is used in both the Recent Questions and Answers index page [Fig. 2] and the individual HTML page for each particular question and its replies.

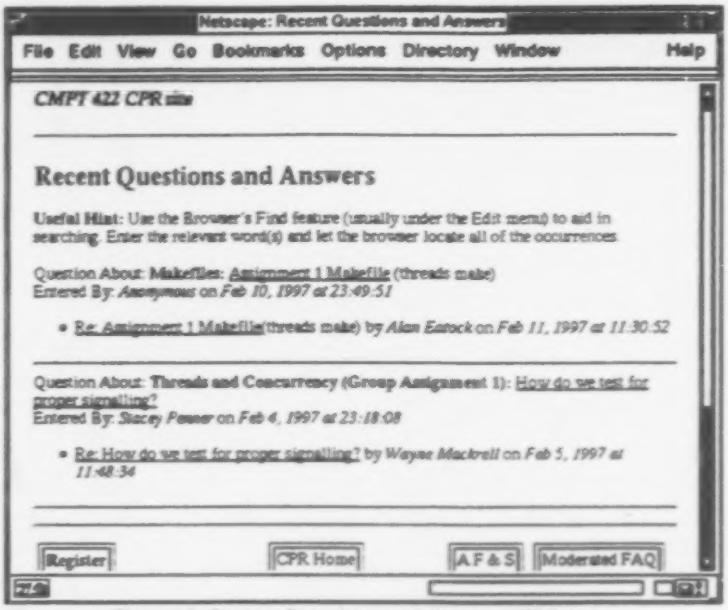
Each entry in the Recent Questions and Answers page consists of a class-specific category or topic; an author (who may be anonymous); subject and keywords (both optional); the posting time; and the text of the question, comment or reply.

If a student posts a question, a peer can post a reply immediately. Thus help can be available to the user on demand. The class experts can be extremely useful in this medium, increasing the possibility of many good solutions being proposed for the same problem. The moderator is also equipped with tools to quickly remove/add entries to the Recent Questions and Answers page. This way erroneous postings can be quickly corrected.

3.2 User Input Help Forms

To help formulate the user contributions and make the postings uniform and easy to understand and navigate, forms are provided. The two types of forms used are the Submit Question and the Submit Reply. The question form contains six fields. The name of the user need not be entered since it is obtained from the database. An option exists for posting anonymously, or publicly (such that the user name, web page and email addresses appear). Users have the option of posting a question or a comment. (The default is a question.) A course specific category table, a list of class specific topics and subtopics chosen and entered by the moderator and instructor is also provided. There is no default category and the user MUST select one from the list in order to successfully submit the entry to the Recent Questions and Answers page. Subject and keyword fields (both optional) are provided for indexing and threading purposes. The text field, where the actual user entry is placed, can be enhanced with HTML tags. (The default is plain text.)

A reply button immediately follows each entry on the HTML page displaying a question and its replies. The reply button brings up a form that has the following fields: user name, text field, public/anonymous posting, and question/comment options, also found on the Submit Question form. Also displayed is the item (question or reply) that this reply is addressing. Optional subject and keywords fields initially contain the subject/keyword from the parent message by default. The user has the option of changing these fields.


Netscape: Recent Questions and Answers
File Edit View Go Bookmarks Options Directory Window Help
Register
CPR Home
A F & S
Moderated FAQ

CMPT 422 CPR site

Recent Questions and Answers

Useful Hint: Use the Browser's Find feature (usually under the Edit menu) to aid in searching. Enter the relevant word(s) and let the browser locate all of the occurrences.

Question About: **Makefiles:** Assignment 1 Makefile (threads make)
Entered By: *Anonymous* on *Feb 10, 1997 at 23:49:51*

- Re: Assignment 1 Makefile(threads make) by *Alan Eastock* on *Feb 11, 1997 at 11:30:52*

Question About: **Threads and Concurrency (Group Assignment 1):** How do we test for proper signalling?
Entered By: *Stacey Power* on *Feb 4, 1997 at 23:18:08*

- Re: How do we test for proper signalling? by *Wayne Mackrell* on *Feb 5, 1997 at 11:48:34*

Figure 2: Recent Questions and Answers Web page

In using both of these Web forms there is an intermediate Preview step that all entries must go through before the item is added to any page. This is important because it gives users the chance to edit their entries as many times as they like before posting. Preview also makes it possible to abort an entry prior to submission. The fact that the entry may contain HTML makes the need for a Preview option even more vital.

3.3 Moderated FAQ and FAQman

The Recent Questions and Answers page periodically needs to be pruned to remove outdated entries. Some of these entries might be discarded, but others should be entered into an archive (the Moderated FAQ) for future use. The design of the Moderated FAQ pages is similar to a traditional FAQ, with a list of class topic categories, cross postings of messages in relevant categories, and a table of contents to organize the postings.

A problem with traditional FAQs is maintaining the consistency of messages that have been posted under several topics, or easily adding to or removing entries from one or more FAQ subtopics. CPR handles this by manipulating the structure of the FAQ pages through modification of the underlying database. Each time the FAQ web pages are reconstructed, updates are automatically made by using the information in the database. This method also makes it easier to maintain consistency when the actual text of the FAQ entry has been modified. There is no longer a need to cut and paste from several files. Only the moderated FAQ entry itself needs to be updated as the changes are reflected in all of the relevant class category pages.

The job of the moderator is made easier because the main task is to organize and maintain the archive by selecting the best peer questions and answers, rather than to dream up questions and provide answers to all of the questions. The majority of the questions will be answered by the user's peers and only the really difficult ones need the moderator. The role of the moderated FAQ is to serve as a repository of reference material available to the class. The information can be expected to be accurate since it was edited by a knowledgeable individual before inclusion, usually after being proposed by classmates.

FAQman, a stand-alone application developed under X-Windows, allows the moderator to allocate credit to students who asked good questions or made useful replies. [Fig. 3] shows a screen shot of FAQman in action. All of the items found on the Recent Questions and Answers page [Fig. 2] are displayed in the frame labeled "xfaqman" [Fig. 3]. From here the moderator can assign credit to the users who posted these messages as well as remove the postings from the Recent Questions and Answer page. He can add, delete or modify entries in the Moderated FAQ pages by using the "Item Editor" frame (invoked from "xfaqman"). These Moderated FAQ

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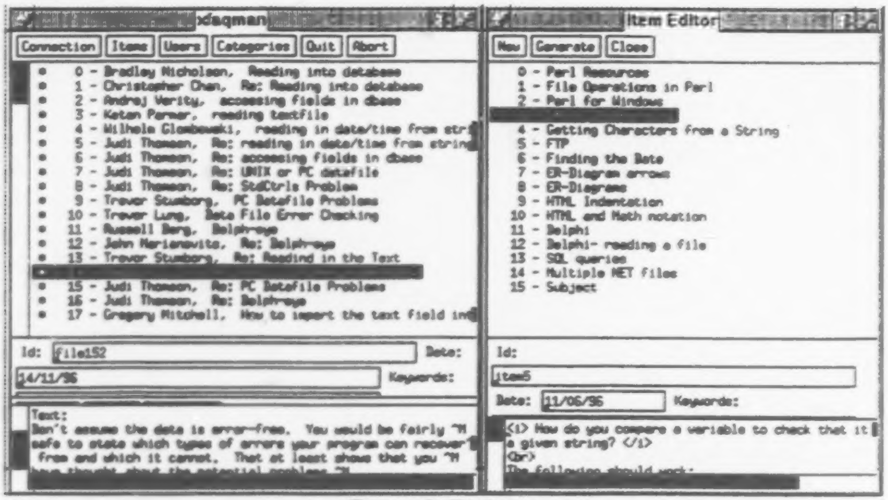
items may either be created from Recent Question and Answer messages or from scratch. FAQman allows an item to be posted over several categories. Only one copy of the entry is stored in the database. The Moderated FAQ consists of a set of web pages with "include" statements and any modifications made to an item are automatically reflected in all of the pages that reference it. The text of the highlighted entry appears at the bottom of each of these frames. In "xfaqman" the entry can only be viewed, while in "Item Editor" the Moderated FAQ item is modified here.



```
0 - Bradley Nicholson,  Reading into database
1 - Christopher Chen,  Re: Reading into database
2 - Andrej Verity,  accessing fields in dbase
3 - Ketan Parmar,  reading textfile
4 - Wilhelm Glombowski,  reading in date/time from str
5 - Judi Thomson,  Re: reading in date/time from strin
6 - Judi Thomson,  Re: accessing fields in dbase
7 - Judi Thomson,  Re: UNIX or PC datafile
8 - Judi Thomson,  Re: StdCtrls Problem
9 - Trevor Stumborg,  PC Datafile Problems
10 - Trevor Lung,  Data File Error Checking
11 - Russell Berg,  Delphrays
12 - John Marianovits,  Re: Delphrays
13 - Trevor Stumborg,  Re: Readind in the Text
15 - Judi Thomson,  Re: PC Datafile Problems
16 - Judi Thomson,  Re: Delphrays
17 - Gregory Mitchell,  How to import the text field in
```

Id: File152

Date: 14/11/96

Keywords:

```
Text:
Don't assume the data is error-free.  You would be fairly ^M
safe to state which types of errors your program can recover
 from and which it cannot.  That at least shows that you ^M
```

```
0 - Perl Resources
1 - File Operations in Perl
2 - Perl for Windows
4 - Getting Characters from a String
5 - FTP
6 - Finding the Date
7 - ER-Diagram arrows
8 - ER-Diagrams
9 - HTML Indentation
10 - HTML and Math notation
11 - Delphi
12 - Delphi- reading a file
13 - SQL queries
14 - Multiple NET files
15 - Subject
```

Id: item5

Date: 11/06/96

Keywords:

```
<i> How do you compare a variable to check that it
a given string? </i>
<br>
```

Figure 3: FAQman

4. Other Features of CPR

CPR has an anonymous area where user concerns and suggestions can be freely expressed. The Anonymous Flames and Suggestions (AF&S) page uses a script that creates a text file, with no means of identifying the sender, that can be used as part of an anonymous evaluation of CPR. The system also provides class email and web page address listing of all the class participants. Password resending scripts are provided to help users choose (and remember) the passwords they desire.

Why would students want to use the system to solve peer problems? One answer is that they too may also need help from the system one day, and if they provided assistance in the past, the favour may be reciprocated. Another reason is that a portion of their course work can be allotted to participation in the use of the system. In this manner, using CPR for students could be a part of the class participation grade.

5. A Case Study Using CPR

At the time of writing, CPR for students had been deployed in two third-year computer science courses each with about 90 students. One of these was a programming intensive operating systems course, while the other was an information systems and Software Engineering course. In the first semester of operation, some interesting preliminary observations and results were noted. Results were obtained from actual observation of the system in use, data provided by the users, and looking at Web server statistics.

In both courses, the system was used frequently with an average of about 250 hits per week by students. The number of hits in the Operating Systems course was slightly higher than in the software engineering class. The average number of postings per week was 30-40 for both courses. The operating systems instructor was a fervent user of electronic help resources, heavily utilizing email, listservs and the Web in previous courses to communicate with his students. This heavy use was also evident in his postings to the Recent Questions and Answers page, as he was one of the most frequent contributors. It was also noted that in this course, many of the harder questions were answered by the instructor or moderator, sometimes anonymously. Apart from this, the level of class participation was relatively widespread across many members in the class, and multiple postings by the same user were not uncommon.

Few of the postings were made anonymously, with students asking any questions they considered relevant to the courses. In both courses, the types of questions posted were typically quite brief and not too

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technical and there were usually several peer responses per entry. Student evaluation of CPR in both courses was most favourable.

6. Conclusions

This preliminary evaluation of CPR has produced the following conclusions. The system, as designed, works reliably. Usage statistics showed a good level of usage of CPR and signs of active acceptance by instructors, moderators and students. The CPR system provides statistics about patterns of student use that instructors can use to determine where further explanation in class is needed. Based on the appraisals of instructors and the comments of moderators and students there is apparent satisfaction with the system. Some of the suggestions given have already been implemented in the newest version of CPR [CPR Demo 97].

Many of the features of WebCT can easily be or have already been incorporated into CPR. The database support of CPR can be extended to incorporate user modeling and information filtering. Work has already begun on a search engine, and the individualization of information filtering is one of the next goals.

To determine what future changes must be made, a more detailed evaluation of the benefits and potential problems with the system must be carried out. Two aspects of the system will need to be addressed in the immediate future. The primitive nature of the database (Mini SQL) presently used in the CPR system poses serious limitations. This is easily solvable by using more reliable and powerful database tools. The current version of FAQman is limited to an X-Windows platform. This will be made more portable once the Web based version is implemented in Summer 1997.

At the University of Saskatchewan, CPR has been deployed in more computer science courses for Spring 1997. One of these is a distance education course. The final goal is full scale use by Fall 1997. Instructors are optimistic that the increased emphasis on peer collaboration can lead to the strengthening of peer bonding and the formation of informal study and help networks.

Long term plans include making use of the CPR database to create individual student models. This will facilitate better deployment of departmental human and printed help resources to meet individual needs. It will also facilitate identification of student misconceptions so that individualized remedial actions can be taken, and identification of student strengths to determine potential peer help resources from within the class.

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Experiences In Facilitating Internet Access For Schools In Ireland

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Abstract: Since 1995, Broadcom, a telecommunications research company, has been providing Internet access to three schools in Ireland as part of a project named "Classroom of the Future". This paper describes the technical and educational issues addressed by the project and makes recommendations on the use of the Internet in the classroom.

1. Introduction

This paper describes Broadcom's experiences in the application of high-speed Internet access to schools in Ireland. The experiences detailed were obtained as part of an on-going three-year research project investigating the uses of telecommunications technology in education. The project was divided into three phases.

In the first phase, Internet access via ISDN (Integrated Services Digital Network) was provided to three schools in the Dublin area in September 1995. The project involved the installation of the technology, providing training and support to the teachers, monitoring and encouraging the use of the facilities, and investigating future applications for telecommunications in education.

Based on the results of the first phase, the second phase of the project was launched in May 1996. This phase involved the development of a Web Site, a guidebook and an informational poster. These materials were designed to encourage and facilitate Irish teachers in using the Internet in their schools. The guidebook and poster were distributed free of charge to schools throughout Ireland.

The third phase of the project is to study longer term issues associated with the introduction of telecommunications into the classroom. It is intended that it examine some of the educational questions in more detail and the application of more innovative technology will be investigated.

2. Background

Broadcom is an independent telecommunications research company based in Dublin, Ireland. The company was established in 1987, as a joint venture between Telecom Eireann, Ericsson and Trinity College, Dublin. Broadcom specialises in research and consultancy in the areas of network management and advanced telecommunications services.

In 1995, it was suggested by Telecom Eireann that Broadcom undertake research on applying telecommunications to education. As a result, the "Classroom of the Future" project was initiated.

At the time of the project's launch, the uptake of Internet technology in Irish schools was quite low. However, the number of Irish schools that are on-line has increased rapidly over the past year. At the moment, we estimate that, of the 780 secondary schools and 3,200 primary schools in the Republic of Ireland, roughly 500 are on-line and 50 have developed home pages. It is noticeable that the on-line schools tend to be situated in more affluent areas or have particular demographics. For example, schools on the Aran Islands, an Irish speaking region, have specially funded computer and ISDN facilities. Most of the major Internet Service Providers offer free connectivity to schools. Overall, Irish teachers are of the opinion that computer education in schools is inadequately funded.

3. Phase 1 "Bringing Down The Walls Of The Classroom"

3.1 Approach

The aim in the first phase of the project was to investigate how telecommunications and computer technology could be used in the classroom.

Since the Internet is the most widely available telecommunications information resource, it seemed logical that our starting point be to provide Internet access to a number of schools and to study its uptake in the classroom. In addition, the decision was taken to provide high-speed access using ISDN. ISDN provides access speeds of up to 128 kb/s and can support a class sharing simultaneous Internet access via the school LAN (Local Area Network).

Three schools were identified as having appropriate facilities and a motivated teaching staff. These schools were Pobalscoil Neasain (secondary, ages 12-18), St. Andrew's College (secondary) and Good Shepherd National School (primary, ages 5-11). A steering group, or Project Advisory Group (PAG), for the project was then formed with representatives from Broadcom, from the schools involved and from the Blackrock Education Centre.

Internet access was provided to the three schools in September 1995 [Jeacle 1997]. Broadcom installed a PC in each school to act as an Internet server for the school LAN, see [Fig. 1]. These servers were configured with the Linux operating system and had an ISDN Terminal Adapter card installed. The Terminal Adapter cards are connected to ISDN lines supplied by Telecom Eireann and wholly subsidised by Broadcom. Thus, via the server and the ISDN network, the schools can access the Broadcom corporate LAN. This allows them to access the Internet via Broadcom's permanent leased-line connection supplied by Eunet, Ireland. The overall system provides the schools with high-speed access to the World Wide Web (WWW), Telnet, FTP and E-mail.

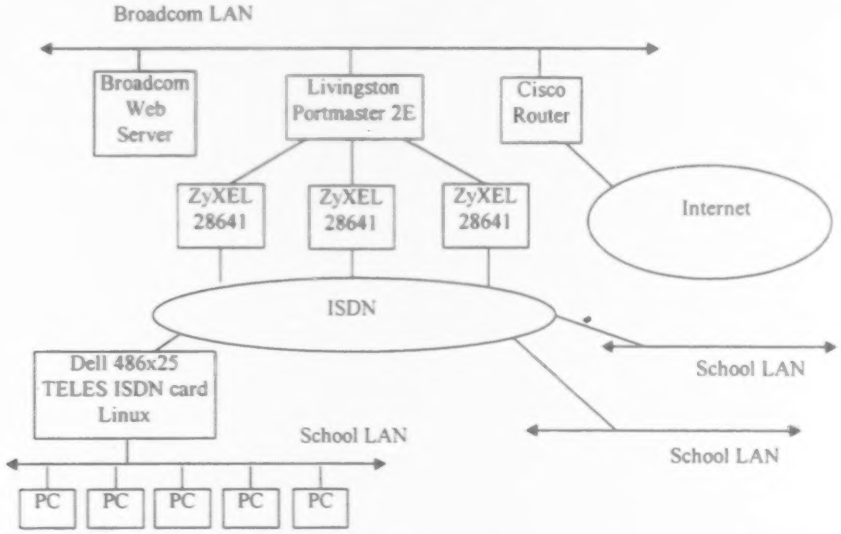

Figure 1: Schematic diagram showing the network configuration used to connect the schools to the Internet via the Broadcom corporate network.

The network configuration described was selected for a number of reasons. First, the Linux servers were cheap to set up and maintain, Linux being a free UNIX implementation. Second, ISDN is well suited to school Internet usage patterns since schools tend to access the Internet sporadically - intensive usage occurs during an Internet-related class, while there is almost zero usage during the summer months. Unlike its leased-line connection to Eunet, Broadcom only pays for the ISDN connections to the schools while they are in use. Third, ISDN allows high-bandwidth access to the Internet, so entire classes can use the facilities simultaneously. Finally, with ISDN the schools are not limited to just connecting to

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Broadcom - ISDN video-conferencing is possible with other schools, businesses and government organisations around the globe. In fact, the Good Shepherd National School has conducted a live video-conference with European Union (EU) ministers.

3.2 Findings

Our findings during phase one are described below. The findings are grouped into three categories according to the use made of the facilities by the schools. The three main uses were found to be: using the Web as a giant reference library, using a home site to promote the school and using E-mail to communicate with other schools.

3.2.1 A Giant Reference Library

Initially the schools used the Internet as a giant, up-to-the-minute reference library. Topics such as the weather proved to be a good starting point. The material was clearly relevant to the subject at hand, in this case geography, and the Web provided easy-access to well-presented, up-to-date information. Similarly, access to foreign language material, such as French newspapers, was deemed very useful since text books are frequently a little turgid and dated. Science is another area which is well represented on the Web. Perhaps not surprisingly, there is little material available on the Irish language. It is hoped, however, that, as it has already done for other interest groups, the Net will draw together geographically disparate groups interested in the Irish language.

The teachers found this reference library approach to the Web to be of use both for themselves and for their students. The teachers found that they could easily and quickly find new and relevant material for incorporation in their teaching activities. Also, they found that allowing the students to seek information themselves was a very positive exercise. First, the students, almost unwittingly, became efficient and confident in using the computer technology. In fact, it was noted that Web browsing is an effective introduction to the use of computers in general. Second, the technology enabled user-driven learning strategies. The students were set a goal and were required to do their own research, evaluating and assessing the information they found along the way. In some cases, it proved that this user-driven learning approach was almost too powerful for the teachers.

In the conventional classroom situation, the teacher "stands and delivers" the lesson. The teacher controls the class and directs their learning. In this context, the teacher is familiar with all the educational material available to the students and can, to a high degree of accuracy, predict what answer they will come up with. In the Internet-enabled classroom, however, the teacher is not familiar with all the educational material available. The teacher does not know what answer they will uncover and, due to the very nature of hypermedia, does not know what path they will use to find a solution. The scenario has shifted from one in which the teacher is the high priest of knowledge to one in which the teacher is the gatekeeper of knowledge.

In our experience, some teachers are unwilling to accommodate this shift in the education paradigm. Some refuse to "let the children loose". They are uncomfortable and feel that the class is out of control. The only way to approach this problem is to equip teachers with the strategies and tools appropriate for this new form of teaching. The teachers themselves must be educated in integrating the new technology into their classroom methods. The problem is not just one of training teachers to use the technology, but is also one of training teachers to use the technology to educate effectively.

3.2.2 A Means For The World To Look In On Your School

Later, as the teachers and students grew in familiarity and confidence with the new technology, some of the schools developed their own home pages. It quickly became clear that school home pages fall into one of two basic categories.

The first category consists of home pages produced by a teacher-champion. These teachers are so interested in the technology that they develop and maintain the school home pages themselves. Generally, the pages are very well presented and are a glossy brochure for the school.

The second category consists of home pages created mostly by students. These home pages tend to be more erratic - the look-and-feel is inconsistent, some links don't work and there may be some negative comments about the school. However, in our opinion, home pages in this category are produced by schools where the students are encouraged to get involved, where they have access to the computer facilities, where user-driven learning is employed and where free speech is promoted. Certainly, having their work put on the Web for relatives in Australia and Canada to see is one of the greatest encouragements a student could have.

School home pages are excellent vehicles for marketing of the school to parents, boards of governors and the Department of Education. Teachers should think carefully about the type of school they want to portray. In our view, a school should focus on what its students are doing, not on what its teachers are doing. We believe that the school's Web site should reflect this.

3.2.3 Communication

Aside from the Web, the schools have access to E-mail and video-conferencing. These facilities have great potential for improving the schools' ability to communicate with the outside world.

For example, one of the schools has used E-mail to good effect in an EU-funded project called Energy (*http://www.psn.ie/projects/energy/index.html*). The project involves schools from seven countries and its goal is to study electrical energy usage in European households. Students collect the data in their homes and communicate the results to the other members of the project by E-mail. It is hoped that the project will promote increased inter-cultural awareness and knowledge of modern communication techniques.

This type of collaborative project exposes students to influences that they would not otherwise encounter. Since Ireland is an island, few Irish school children have been to two other countries, let alone six. Different cultures can best be appreciated by experiencing them. There is only so much that can be picked up from a text book. It is only via the close contact facilitated by telecommunications technologies that this sort of exposure can be achieved in a cost-effective manner. In this type of project, students learn, not only about the stated project topic, in this case electricity consumption, but also about the world in general.

However, interaction between schools must be given a *raison d'etre*. One of the reactions which we encountered when trying to promote the use of E-mail and video-conferencing was the comment: "Well, why would we want to talk to other schools?". Teachers are used to giving a solo performance in the classroom. They must clearly be shown the advantages of introducing new influences. The kids also need an ice-breaker - a common purpose with the other students - something to get them talking. Once they have started it can be difficult to stop them. Also, the regularity of communication seems to be important. A once-in-a-while approach engenders a careless attitude, while an everyday approach creates a sense of anticipation.

Furthermore, communication is a two-way thing. It is up to both parties to put in the effort. This pressure weighs particularly heavily on the shoulders of the already over-burdened school teacher. More often than not, the teacher's principal will view these projects as extra-cirricular activities, to be added on at the end of the school day. Projects such as these should be integrated into the day-to-day activities of the school. Teachers who are sufficiently motivated to get involved should be encouraged by being given time to contribute, not penalised by being over-worked.

3.2.4 Summary

There were two main conclusions drawn from the first phase of the project.

First, practical issues are uppermost in the minds of Irish teachers. Computer technology is expensive and is not well funded by the Department of Education. Schools pay peak rate prices for the use of phone lines. Even if the school has a computer and modem, creating easy access for students is a problem. Most schools do not have a dedicated computer room. Thus, teachers are either forced to bring the computer to the class on a trolley and trail a telephone cable down the corridor, or have to bring the students to the principal's office in order to use it. The former makes it difficult for the teacher and the latter is hardly conducive to the free expression of the students' opinions.

Second, we found that once these practical issues have been solved, as for the teachers involved in our project, a number of conceptual issues became important. Teachers are faced with a new teaching tool. They have been given little or no training in how to use it successfully in the classroom. The problem comes down to the individual. Some tackle it with vigour and are successful, usually after a few false starts. Some give up and try to ignore it. Still others, view it as their personal toy - something too valuable to share with the students.

4. Phase 2 "Enabling The Educators"

4.1 Approach

In phase two of the project we decided to address some of the conceptual issues on a national basis. To this end, we undertook three initiatives designed to promote usage of the Internet in Irish schools and to help teachers apply the technology in their classroom. The three initiatives were as follows: to develop an educational Resource Site on the Web for Irish Teachers, to commission a free booklet for teachers entitled "A Guide to using the Internet in Irish Schools" and to produce a free poster on the Internet aimed at school children.

4.1.1 A Resource Site for Irish Teachers

One problem frequently encountered by teachers new to the Internet was the question of where to find anything useful. As we all know, the Web can be intimidating and finding a useful piece of information can be like trying to find a needle in a haystack. The Resource Site we have developed is designed to be a first port of call for teachers who are searching for useful material (*http://classroom.broadcom.ie*).

The site was developed by two secondary level students who were employed by Broadcom over the summer holidays. The students had some prior experience of developing home pages and quickly adapted to the Broadcom working environment. Their work included developing HTML pages, writing CGI scripts and setting up mail servers. With little direction from the permanent staff, they have produced a site which is both professional and functional. In our opinion, the site is an excellent example of what school students can produce when they are motivated and empowered.

The site includes:

- a library of links to educational resources on the Web categorised by subject
- a map of Ireland which can be "clicked" to retrieve a county-by-county listing of on-line schools
- a system for teachers to develop on-line worksheets
- information on useful Internet tools, such as IRC, Usenet
- home pages for the three schools in the project
- an on-line version of the Internet guidebook
- a guest book and a mailing list

Eventually, our intention is to hand the Resource Site over to an Irish educational body who will maintain it on an on-going basis.

4.1.2 A Guide to Using The Internet in Irish Schools

Since the booklet was to concentrate on the conceptual issues of using the Internet in education, rather than on the technical issues, it was decided to engage the services of two teachers with practical experience of using the Internet in their classrooms. Although it contains information on how to get online and how to use the Internet, the focus of the text is on how it can be used effectively in the schools. The booklet is full of examples of how the Net can be incorporated into Irish school life.

The booklet includes:

- an explanation of the Internet
- subject-by-subject examples of how the Internet can be effectively employed in schools
- case studies of how teachers involved in our project have used the Internet
- a guide to getting on-line and using Internet tools, e.g. Web browsers, E-mail, FTP

4.1.3 A Poster for Irish School Children

The poster is designed to encourage and motivate schools kids to use the Internet. It provides a brief explanation of the main tools and gives an Internet Timeline to help students understand its history. Also included are screen-shots of the Broadcom Resource Site and of the Irish Times site on the day Michelle Smith won her fourth medal for Ireland at the Atlanta Olympics.

4.2 Findings

The reaction to the three initiatives has been extremely positive. The project has been featured on national television, radio and newspapers. The Resource Pages have been accessed from over 5,500 distinct hosts in 50 countries and we have had over 2,500 requests for the booklet and poster. We have received encouragement, thanks and congratulations from teachers in Ireland, Norway, Sweden, Canada, and the USA: "It's great to see the resources available", "The way of the future", "Keep up the good work", "A very welcome development".

5. Phase 3 "Long Term Research"

Our goal for the final phase of the project is to examine some of the longer term issues involved with the application of telecommunications technology to education. Although this phase of the project has not yet started, the approach that seems most appropriate is to fund educators who will conduct the research and to supply the technical support and expertise ourselves.

6. Conclusions

We have drawn a number of conclusions from our experience working with educators on the introduction of Internet technology to schools in Ireland.

First, appropriate training for teachers is essential. The move to Internet-enabled teaching involves a paradigm shift in educational methods. Teachers must be taught how to subsume the new technology into their teaching techniques and must be shown how to get the best from the facilities and the students. Clearly, training such as this is expensive to implement. However, any investment in computer technology is pointless without it.

Second, to get the most from any telecommunications technology, the user community must have a common purpose which will drive their interaction. Without a rationale and the commitment of the parties involved, the dialogue quickly becomes redundant. In our opinion, national and international educational institutions have a role to play in facilitating and developing this communication. In particular, the European Union has much to gain in strengthening the cultural links between students within Europe. We are headed for an integrated Europe, Irish children must see themselves as part of it.

Third, technologists can only assist educationalists in applying information technology to schools. It is up to the educationalists to solve the educational issues.

Finally, educating our children in the use of technology is essential for the future economic well-being of our nation. Ireland missed the Industrial Revolution, it cannot afford to miss the Information Revolution.

7. References

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Investing in Computerized Training: The Interactive Decision Aid System ECONOF

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Abstract : The paper describes an aid system for the decision of investment in computerized training, named ECONOF. It is an application software based upon a multicriteria model. It is dedicated to the decision-makers within business. ECONOF helps them to determine the economics of investing in a computerized training program. The development of ECONOF needed a prior judicious criteria choice as well as a particular criteria organization. Each criteria proposed by ECONOF was found within the literature. Examples of criteria are provided in the paper.

1. Introduction

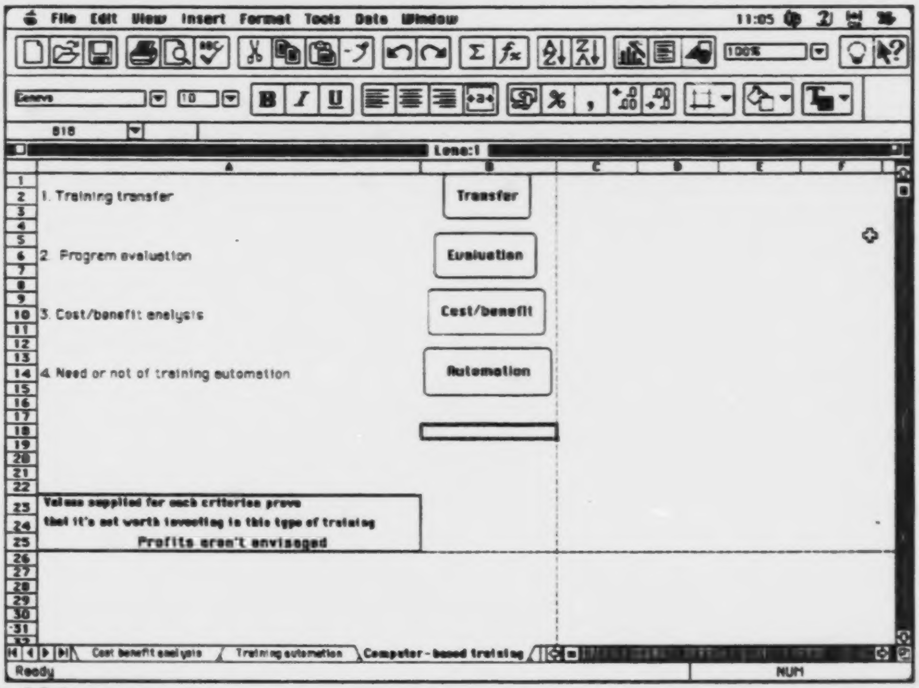
In a time where the world economical situation is going from bad to worse while in the same time, the technology evolves on a daily basis, much interest is focused on the economic aspects of computerized training. Nowadays, an organization which wants to get an important share of the market, considering markets on a world-wide scale, must turn to the training part. Consequently, an organization is led to manage its intellectual investment [Caspar and Afriat 1988] [Davis 1992] [Kelly 1994] [Toffler 1992]. It must also actually benefit from learning and teaching technologies.

The use of technology in training presents many advantages. Among them, [Maginn 1987] mentions the following: "Probably the most encouraging research finding involving individualized instruction from an economic point of view is that use of this medium saves a great deal of training time-sometimes up to 50 percent. And, these time savings translate into redirection of man-days for both students and instructors. Put another way, less training time means less time away from the job". Other advantages mentioned in the literature are: timetable flexibility, equipment portability and being able to ensure continuous training. The use of technology in training can constitute an investment of great significance. Therefore, any administrator, before establishing any form of computerized training, must be able to persuade himself or herself, somehow, that the decision in progress will constitute a crucial contribution to his or her organization. An example of such a decision can be found in [Robinson and Robinson 1990]: "Supervisors justifiably had put employees on probation 48 times; 20 of these employees eventually left the organization. Because rehiring and retraining for the 20 open positions had been costly to Homespun, the company hoped that a training program might reduce the expense".

The aim of the study described in this paper was to provide an aid system for the decision of investment in computerized training. The aid system is named ECONOF. It is essentially an application software developed according to the precise situation of deciding to invest or not in computerized training. The aid system ECONOF is based upon the multicriterion model concept and is essentially built on consequences that different actions entail. It relies on the balancing criteria method summarized in the second part of this paper

[The balancing criteria method] and then, needed a prior judicious criteria choice as well as criteria organization in what is called themes (consequences clouds). Each criteria proposed by ECONOF was found within the literature. Consequently, the proposed multicriterion model takes four themes into account. Those themes were defined after analyzing the specialized literature such as : [Adams 1993] [Campeau, Olfman, Sei and al. 1995] [Coppolino 1986] [Davidove 1993] [Fitzgerald and Cater-Steel 1995] [Garavaglia 1993] [Montebello and Haga 1994] [Nasman 1989] [Ryan Nelson, Whitener and Philcox 1995] [Shelton and Alliger 1993] [Solomon and Templer 1992] [Tannenbaum and Woods 1994] [Zemke and Gunkler 1985].

The ECONOF's themes are: training transfer, program evaluation, cost/benefit analysis and need or not of computerized training. They correspond to the main menu presented at [Fig. 1].



1. Training transfer

2. Program evaluation

3. Cost/benefit analysis

4. Need or not of training automation

Values supplied for each criterion prove
that it's not worth investing in this type of training
Profits aren't envisaged

Figure 1 : Main menu.

The aid system ECONOF takes different criteria into account through actions and situations choice proposed to and selected by the user. Each user's choice corresponds to a weight. A total is then calculated. We insist on the fact that each criteria, action, situation or consequence was established after analyzing the specialized literature. As example, [Zemke and Gunkler 1985] wrote: "The discussion can cover a number of topics: What the training will cover; why the trainee was chosen to participate (or was okeyed for participation); why the training is important to the trainee and to the organization; the supervisor's assessment of the trainee's strengths and weaknesses as they relate to the content and objectives of the program; specific projects or problems related to the content and objectives of the program that the supervisor would like the trainee to work on during the training sessions; and how the supervisor will help the trainee apply the new skills and knowledge when she or he returns from training". Several criteria are listed in this citation.

From the total, the system ECONOF generates an interpretation according to the treated theme and, it's once total interpretations of each theme are got that an interpretation that synthesizes those of all themes is performed. Finally, it's that interpretation synthesis that suggests, to the user, the decision to make, i.e., whether the decision of investing or not in computerized training is a profitable or not profitable decision. That is expressed in term of profits in order to help an administrator in her or his decision about a training program before it is done.

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2. The balancing criteria method

When a decisional context is characterized by a great complexity, this method is useful because it guides the intellectual progression, putting each factor, each relation, in a structured system of thinking. There are diverse methods for deciding more rationally. Nevertheless, they all refer to a process in five stages being :

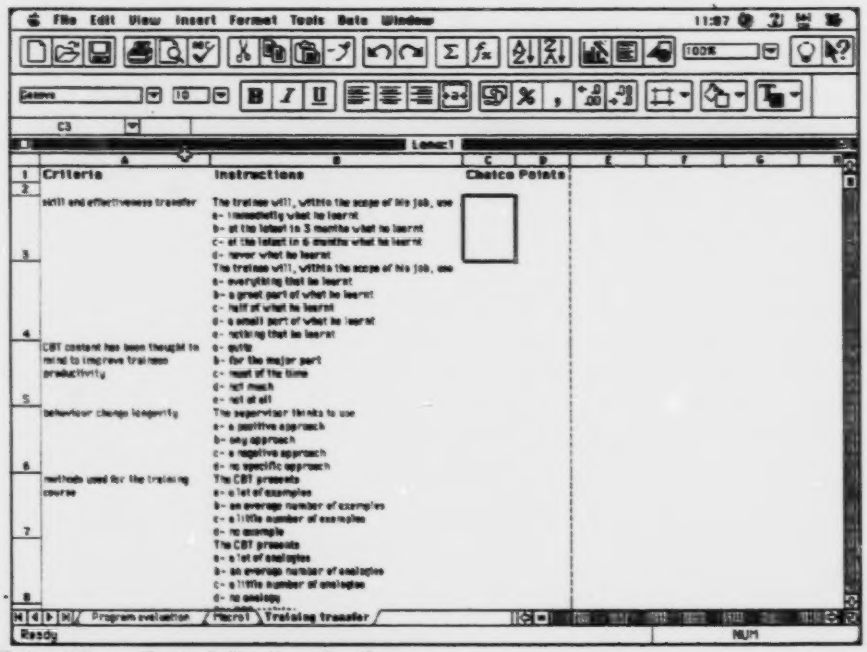
1- to identify, choose and define the aimed objectives. To formulate them in terms of operational criteria measuring the attended results. To allocate a relative importance to these diverse criteria (the criteria column at [Fig. 2]).

2- to look for and to delimit the field of solutions or strategies, i.e., to make a list of possible actions that can contribute to the solution of the encountered problem (actions in the instructions column at [Fig. 2]).

3- to identify the situations that can be envisaged or variables that can modify the result of envisaged actions (situations in the instructions column at [Fig. 2]).

4- to assess the action consequences according to the situations. This is establishing the "points" category that will be considered in the model (the choice column at [Fig. 2]).

5- to evaluate the optimal strategies comparing the way that the expectable results of each of them satisfy the valued criteria, and to select the appropriate action retaining the one that has the greatest chances to result in pursued objectives achievement (the points column at [Fig. 2]) and the subsequent total and interpretation (an example is presented at the bottom of [Fig.1])).



	A	B	C	D
1	Criteria	Instructions	Choice	Points
2				
3	skill and effectiveness transfer	The trainee will, within the scope of his job, use a- immediately what he learnt b- at the latest in 3 months what he learnt c- at the latest in 6 months what he learnt d- never what he learnt		
4		The trainee will, within the scope of his job, use a- everything that he learnt b- a great part of what he learnt c- half of what he learnt d- a small part of what he learnt e- nothing that he learnt		
5	CBT content has been thought to mind to improve trainee productivity	a- quite b- for the major part c- most of the time d- not much e- not at all		
6	behaviour change longevity	The supervisor thinks to use a- a positive approach b- any approach c- a negative approach d- no specific approach		
7	methods used for the training course	The CBT presents a- a lot of examples b- an average number of examples c- a little number of examples d- no example		
8		The CBT presents a- a lot of analogies b- an average number of analogies c- a little number of analogies d- no analogy		

Figure 2: Extract from the training transfer theme.

The balancing criteria method that is used in ECONOF is useful in the case that many objectives are pursued at the same time and one another independent. The resultant criteria are numerous and it takes to balance them to look for the optimal solution, at least if there isn't a best solution than the others on all the plans. One

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will then retain one solution that allows at best to reach at least one's main objectives in a satisfactory way, although it may mean to do some sacrifices. So, the fact of allocating to criteria definite weights and definitely fixed makes things easier. The usefulness of that method is explained by the fact that complex decisions are usually multicriteria. That means that the decision-maker has many reference values to judge the diverse solutions between which she or he has to choose.

3. A few criteria

The decision aid ECONOF can help provide a structured way to look at issues involving the trainees and the corporate climate. It isn't intended to help the design of a particular computerized course neither to serve as a guide for matching the content of the training course, i.e., the actual learning objectives with the best possible instructional medium. The multicriteria model summarizes a number of key considerations that are generally true of computerized training and are represented by criteria organized into themes. Criteria are the translation, under an operating form, of the identified objectives and constraints of a particular business.

Before explaining some criteria, the aim of each theme will be given. For the theme of training transfer, ECONOF checks if the transfer is done at the time of the training course. The theme of program evaluation evaluates if immediate instructional objectives are reached. The cost/benefit analysis theme sets the link between the investment in training and the accomplishment of specific business objectives up. At last, the training automation theme that complements the cost/benefit analysis and helps see if the computerized training is indeed the best way to decide a particular training project. Now, some criteria taken in any of the four themes will be listed:

- From *training transfer* theme -> criteria *skill and effectiveness transfer*: (top left at [Fig. 2]) or criteria *methods used for the training course* (bottom left at [Fig. 2]).

- From *program evaluation* theme -> criteria *training cost evaluation*: one aspect to assess that corresponds to the instruction column is: *Present trainees productivity in regard to tasks that are taught by computer.*

- From *cost/benefit analysis* theme -> criteria *elapsed time between training course and new knowledge use:* one example of aspect that corresponds to the instruction column is: *It's anticipated that trainees wait after their training: A) Not at all; B) A little; C) Some; D) A long time.*

As mentioned before, for each theme, there are criteria. Criteria correspond to actions or situations stated in the instructions column. Those actions or situations have assigned points category. For example, a positive action or situation for the business might worth 10 points while a negative one might worth 0. When the decision-maker has completed the assessment of a theme, points are added. For example, when the total in training transfer theme is less than 90, ECONOF will advise her or him that the training is at risk to fail in regards to the training transfer. There is a total calculated for each theme. Then, ECONOF takes all these totals to produce a global interpretation. An example is shown at the bottom of [Fig. 1] : the result of the analysis ECONOF made in regards to values supplied for each criterion prove that it's not worth investing in this type of training. Profits are not envisaged. Note that some of the point values can be modified to reflect one's own organization's circumstances. For example, if managers' past experience with computerized training has been truly awful, one might use negative points for that consideration rather than merely assigning no points. When point values are changed, ECONOF will ask for compensating before proposing any comments on the partial and final totals.

4. Conclusion

Training is pervasive, expensive and strategically important. The spread of new technologies depends on their fit with work context, knowledge about the technology, technological infrastructure, and community beliefs about the technology. So, decision makers need the help of decision aid systems to reduce training investments and increase training effectiveness. The result of this decision aid is to help decision makers to make the right choice in regards to invest or not in computerized training. The system ECONOF gives for each theme only two possibilities: that of implementing computerized training and that of not but adds to our understanding of many aspects of it. However, even more research attention needs to be focused in the future on the possibility of giving more than two suggestions to the decision makers, on the areas of computerized learning rather than training, transfer of learning to the workplace, etc.

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FOUR JOURNEYS WITH TECHNOLOGY: GETTING SOMETHING WE DIDN'T PLAN FOR

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Abstract

Abstract: Teachers are often forced to be received knowers in implementing technology because of institutional or government directives. Four of us have been engaged in an ongoing conversation that has re-affirmed the importance of fostering communities of connected knowers where dialogue enables us to personalize our knowledge within our working contexts. Our immediate community includes two teachers, a principal, and a university instructional designer. From our conversations, we have written our stories of how we are making sense of technology in our work. Although told individually in this paper, the stories are lived out in a collaborative learning community where we grow and learn from each other.

Change theory proposes many models for successful development and implementation of new educational practices (Fullen, 1991). While acknowledgement is given to involving teachers as active participants for successful innovation and planning (Fullen, 1991; van den Akker & Plomp, 1992) we have also come to realize that changes can cultivate new ways of seeing ourselves as teachers and learners. We as teachers may be seen to implement and/or affect changes, but, how do these changes alter our personal/professional landscape? Moving into new territories with technology has offered us an opening for enrichment of this landscape.

Our recent work at our school in opening up possibilities for our children has launched a philosophical conversation. Technology has become not only a tool by which our students may pursue new learning possibilities but also a vehicle by which each of us is alerted to our basic personal beliefs and fears about our work. It is also a means by which we are pursuing new ways of seeing ourselves as learners/teachers, composing new stories of collaboration with each other and our students. Each staff member has carved his/her own path and yet, many shared dreams have

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emerged. Anderson (1995), Kazlauskas (1995), and Schuttloffel (1995) have offered possibilities and models for successful implementation of technology. We would like to take these one step further and offer the stories of implementation of technology at our school as portraits of personal and professional growth within a collaborative learning community.

This paper includes highlights of the history of technology implementation at our school. In particular, four of us have met to discuss our own journeys: one as a special education support teacher (Kathy), another as a grade two teacher (Kathleen), a third as an instructional design consultant with the University of Alberta (Katy), and, finally, a school administrator (Laurie). Each of us has a different story of how technology has become part of our lives. Our current school context is the thread that connects us. Through our stories, we hope to share insight into the complexities of life in schools, particularly as it relates to our personal/professional growth with technology.

Kathy's Story

In the past decade it seems that we have been bombarded with new technology tools and programs. The media hype and the excitement that technology innovations have caused in the outside world have made us very anxious to get involved and try out these ideas with our students. While I can see the usefulness of these tools, I continue to ask questions about the change in my pedagogy that technology demands.

Do computers save us time and effort at school? Definitely not at the beginning of their implementation. In fact, quite the opposite is true. I have spent hours learning, experimenting, failing, and trying different programs and tools. However, once I have successfully used a program and integrated it into my planning and my students' days, it is hard to imagine what I ever did without it.

The most significant change in my job has come from my own use of technology. It seems like the computer has crept into every aspect of my teaching from test management and student records to worksheets and activities. I have learned to use a very limited amount of what we have available and keep looking for time to learn, practice and experiment with other tools.

I think that using computers depends largely on your comfort level around this machine. The only way to increase that comfort level is to use it and the only way to use it is to find the time to try. Yet, unless we trust that this will someday make life easier or that technology is important to our students' learning and to our teaching, we will never allow ourselves the time to be the learner.

When I first started using computers I thought this would be the answer to the massive amount of record keeping that goes with my job. I started to record (painfully) on floppy disk, all of my objectives and units from my special education curriculum. Needless to say, this was like the never ending story. Long before I ever found the time to finish my project, the technology had changed to the point that I could no longer used the disks that I had created. Although this was a time consuming endeavour, it was also a wonderful learning experience and greatly increased my comfort level with computers. However, it makes me very cautious about what we are spending our time and money on at our school. I also spend more time thinking and debating the value of programs or new innovations.

Kathleen's Story

I grew up in a home where technology showed very little of its rapid growth. It wasn't until I entered university in 1975 that my mother finally put away her old wringer washing machine and bought an automatic washer. A microwave did not follow until the late 1980's, and only in the last few years has a VCR invaded my mother's home. There are still no signs of a dishwasher, and computers and computer language is as foreign in that home as a far away exotic language would be.

As a child growing up in this setting, I inaccurately determined that technology must be quite dangerous, and something to be avoided. After all, my mother was a teacher, and if it was a good thing, I felt sure that she would be making use of it. Only years later, looking back, have I come to the realization that finances were the real reason that technology was so slow in entering our home. I took my misconception with me to university. While some technology was available to students in the library, I never made use of it.

Eight years ago, technology was introduced into the school where I teach. Classrooms received computers and heavy inservicing followed. The computer was to be used mainly as a way to strengthen students' skills through games. I strongly dislike games, and so now I had two reasons to dislike technology. Firstly, I still saw it as a danger, and secondly, it was another medium for playing games. (This focus has since changed. Computers are now more often used as tools for writing stories and reports, and more recently, for researching.)

Luck was with me, I thought, as I was in a position teaching music and physical education and neither course involved computers. I hoped that no one would notice my absence from the inservicing. On those nights I ran from the school as quickly as possible, trying to mingle with parents who had come to pick up their students.

Shortly after this year of computer introduction, I was assigned a grade two classroom complete with a computer, and a stack of disks. For a few months, the computer sat shrouded in the corner. Then, finally, I decided that the students should be able to use it for drill and review, and I learned the basics from other staff members. To anyone looking in, I would have appeared comfortable with technology. However, other than turning the computer on and off, I still had no connection with it.

Technologically speaking, those were difficult years. I had come to realize that I had incorrectly assessed technology as a child. However, it still frightened me. At the same time, I felt like the rest of the staff had climbed on to a locomotive, and I had elected to stay behind at the train station. I began to doubt my abilities and felt that I had very little to offer the teaching profession. I was not connected to my technological peers.

A year ago, Katy, an instructional design consultant from the University of Alberta came to our school to inservice us in technology. At the beginning of the day, I felt as if we had been transported to another planet. The newness of the technology that Katy showed us overwhelmed many teachers who were comfortable with the technology in place at our school. It left me speechless.

Katy showed us how to use the internet and e-mail. Even though we had some problems using the internet that day, I became intrigued with the communication possibilities that were being opened up to us. Coming from a small rural area, it is often impossible to make connections with a lot of people who can broaden and intensify our learning. Katy was offering us a door to the entire world. Within weeks, I was closeting myself daily with the Internet. Teaching became alive as my grade two class and I researched animals and countries for classroom projects. I e-mailed with a passion.

I began to take my students to the lab for very basic keyboarding. As they absorbed my enthusiasm, they became relaxed and comfortable with technology. Some of the weakest students have flourished, finding great success in our lab, where we are all on a fascinating journey of discovery.

For myself and my students, technology is building a bridge across the distance of rural living to people all over the world. Like chefs creating new meals, we are creating new connections, becoming open to new ways of learning. Our circle of communication grows daily. Personally, I feel recharged as I once again assume the role of both teacher and learner, moving toward the next century with enthusiasm and anticipation.

Katy's Story

I was invited to enter the process of school-based technology planning in the way that I have always come to the

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practice of educational technology - through relationships framed by the personal. Relationships are the social context in which I design and in which I am able to best explore, and share the experience of technology in my work. I do this through conversation.

I had first worked with Laurie, the principal of Rocky Elementary, on a videodisc project in teacher education. The project belonged to the content expert, a professor in Elementary Education, and Laurie was his graduate student assistant. I was the instructional designer. Through the conversation-based process of design Laurie and I created a social space in which the design process became a process of sharing teaching and personal experience. We became friends and, through that relationship, colleagues and design partners. Laurie knew, and had helped me write, my story of becoming a multimedia instructional designer.

Like so many of us who call ourselves Instructional Designers, I have an experiential base to my practice which only later (and only sometimes) seeks validation through formal training and credentials. Personally, I seek authorization to do what I do - to be, in effect, the expert - through the tacit agreement of my work partners. I enter into their worlds and make my own understanding of technology accessible through talk about experiences with teaching and technology. Self-taught, like they are, I chose a technology model because I had an instructional need best solved by technology-enabled instructional strategies. I did not fall in love with technology as an entity. (That came later). I know that teachers, and university professors, will only approach technology through needing to solve a problem and sharing stories of their solutions and the related tribulations with other teachers who have already been there.

I was invited to an inservice at Rocky Elementary as an Internet expert. Far from being impatient with the resistance to embrace a mostly ubiquitous technology because "what if the network goes down in the middle of the lesson", or becoming defensive about the reliability of 1996 technology, I told the story of my own confrontations, as the technology expert, with constantly failing technology. I entered into the world of the classroom teacher who cannot afford to problem-solve a failed Internet connection for even five minutes with a class of restless 7-year-olds, and worked with the assumption that technology will fail, and how we can recover from that. In the afternoon, I was invited to model my practiced serenity in the face of technological havoc as the school network went down and stayed down all during my hands-on workshop. And I'm told that in so doing I brought the teachers, feeling immensely relieved, into my world of sometimes uneasy alliance with technology for teaching.

Laurie's Story

In 1994, I thought I knew about technology, or, at least some of the possibilities that technology could offer our students. I had embraced it as part of my own classroom teaching since 1980 and had been very active in professional development related to technology. My journey at Rocky Elementary since 1994 has taken me to places I could never have imagined. I have been a privileged observer and participant in a wonderful journey of discovery as I have watched new relationships evolve through dialogue and debate about technology. These relationships have been the foundation for support as teachers have wrestled with the frustration and excitement that technology can bring. Conversations continue spontaneously in the hallways during and after school, at inservices, in our meetings for our technology plan (involving para-professional staff and parents), and now in our writing about our experiences. For us, planning for, and utilizing technology has become another starting point for reflection.

When I came to the school as the principal in 1994, I arrived at a place where many teachers were using computers in exciting ways in their classrooms. For others, computers remained under covers, unused in a corner of the classroom. How could these teachers begin to see themselves as part of the dialogue about teaching and learning with technological tools? In their resistance, I sensed their feeling of being left out and apprehensive about the time that technology could demand of them while at the same time being reluctant to open the doors to new possibilities. Computers had been a mandated part of life for grades four and five teachers for several years with support provided by a teacher (Karen) who was given a portion of time (.2) for technology. I looked for cracks in the doors and tried to provide as many places and spaces as possible for dialogue about changes.

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Many doors opened through the broadening of our technology planning process. Whereas Karen had done the majority of the planning until 1995, an increase in the decision making authority of teachers through site-based decision making enlarged the circle. Our staff realized that having the authority to determine where and how our budget would be spent also required careful thought and planning. Our first meeting of the "Step-Forward" committee, held in the fall of 1995, had 17 volunteers in attendance (professional staff, support staff, and a parent representative). This committee was originally formed to address changes that we wanted to see in our library, however, we soon realized that it would become our school plan as it related to technology. I found myself as an observer rather than an active participant. A synergy evolved that allowed me to step back and enjoy watching the direction that the group was heading in. The enthusiasm and energy of each member generated exciting discussions about what we should be doing with our technology and how teachers and students would access the support they needed. A plan evolved whereby our new computer purchases would replace the old ones in our grade one classrooms, followed by the twos, and up to the higher grades as we could afford it. We talked about supporting ourselves with professional development and sent eight teachers to a local conference on technology. The group travelled together to the conference and indicated that a highlight was the two hour drive home at the end of the day. The sessions had cultivated new ways of seeing technology for many and the conversations in the van were buzzing with excitement. Shortly afterwards, I watched many covers come off of computers in the corners of classrooms.

An inservice in the spring opened up new conversations as I invited Katy to work with us in our exploration with the Internet. Having worked with her on several other projects, I knew that she would bring another perspective from the University while at the same time understanding the frustrations that we were facing in the classroom. A pre-requisite for the workshop was that all staff members were asked to send an e-mail to Katy and we set up written instructions in the corner of our lab so that staff could complete the task according to their schedules. Those who were comfortable helped first-time users and several overcame the hurdle of delving into the internet through one contact with Katy. During the inservice, our first about using internet, Katy was unable to access a connection for the entire time. Instead of affirming our apprehensions about technology, the relationship that Katy developed with the staff helped to alleviate many fears that people had. She continued talking about her work and the possibilities the internet could offer. In watching Katy, an expert in her field, calmly continue in spite of the technology's unpredictability, a new comfort emerged for many workshop participants. Now it is not uncommon to find teachers at school late Friday evenings, receiving and sending e-mails to new connections they have made all over the world and discovering many possibilities through web searches.

Our Step-Forward committee continues to meet on a regular basis. In making our school plans last spring, and based on the recommendation from the committee, teachers unanimously voted to give up a half hour preparation period each in order to release a half time position more for technology support. With creative budgeting and utilization of our old computers, we have two labs and two technology support teachers. Our grades one, two, and three students can now explore computers in our second lab and exciting new conversations are opening up between young children as they help each other log on, find icons, and weave their way through programs. This has also facilitated exciting new team-teaching opportunities with Kathy as our second technology support teacher. Karen and Kathy have set aside Tuesdays (an hour after school) for drop-in professional development activities related to technology and each session is full.

This journey continues to be two steps forward and one back as we live with the elation and frustrations that technology can bring. However, it has also become one for forging new working relationships with each other and professionals outside of our school. In sharing our struggles with each other we are able to find safe, supportive spaces in which to continue the debate about how best to meet our students' needs.

Possibilities

We, as educators, need to continue to feel success in various areas of our lives. In this way, we are able to experience the success and excitement of learning that we want each of our students to have. Technology in our school is offering educators the chance to experience this excitement. We have a variety of technological encounters available to teachers, and as the requirements are manageable, teachers need not feel threatened by the enormity of technology. Rather, we all have the opportunity to experience being student and teacher as together we work our way along the technological highway.

Our collaborative conversation has led to the development of a community of connected knowers. Communities of discourse, as Tarule (1996) tells us, become sites for promoting and enhancing development. Through coming to a constructed knowing about technology, we situate experiences in the personal domain and therefore, are enabled to translate our knowing into practice that makes sense to us in our work. We envision possibilities instead of enforcing directives, and therefore innovate rather than implement.

Two questions arise from our personal/professional journeys with technology: first of all, is it the nature of technology itself that engages us in dialogue thereby facilitating collaboration? Technology demands dialogue since we are all beginners in many ways. At the same time, there are many threads of continuity for, although it is a new medium, technology does not dismiss the importance of relationships in our work. If anything, it offers new possibilities for broadening collaborative relationships. Secondly, is it that our staff is already on the road to new ways of being teachers/learners and technology just happens to be the catalyst? We would suggest that our growth may be based on a combination of the two; our staff has the opportunity, and is open to engage in reflective conversations about our practice. Technology offers many new landscapes for this dialogue and collaboration.

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The Evolution of an Electronic Teaching and Learning Environment

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Abstract: The use of new media for teaching and learning is only at its beginning. It varies from multimedia applications for individual learning to different forms of teleteaching. However, learning is an inherently social process and most of our educational activities take place in institutions where students and teachers spend a certain amount of time together.

This paper describes our attempt to support learning by establishing an electronic infrastructure where we can integrate all kinds of materials needed and which is accessible from all places where learning takes place. It turns out that establishing such an infrastructure is a long and tedious learning process itself where didactic, organizational and technical problems are strongly intertwined.

1 Introduction

During the past few years, hypermedia systems have made their way into teaching and learning processes at universities. In most cases, CD-ROMs or the World Wide Web are used to support the dissemination of documents such as lecture notes or background material. While many authors suggest to replace lectures by courseware, we follow a different approach, namely to support socially embedded learning processes through the use of new media. Up to now, documents were only accessible in certain places, such as the university's computer labs or the PC at the student's home, but not in classrooms and lecture halls. Thus, we are far from a seamless information environment where new media support the teaching and learning process throughout.

In this paper we will describe our way towards an integrated electronic teaching and learning environment which we see as an on-going process of implementing technical innovations, using the environment in our daily teaching, exploring new concepts and teaching methods, and evaluating the whole setting. First, we will look at some technical aspects of university teaching and point out problems originating in technical deficiencies. We will then describe, how we started with publishing course material on the World Wide Web and continuously improved the material to an open hypermedia document base which can be worked upon actively by the students. The integration of the material and documents which are created by the students into the courses marks the beginning of an integrated teaching and learning environment where the hypermedia system can be used to support lectures and seminars as well as individual learning. We will report how the technical innovations influenced our way of teaching and how in turn our experiences with the environment determined its further development.

2 Technical Problems in University Teaching

In the sciences and the engineering disciplines at German universities most courses consist of lectures, tutorials, and student assignments. A typical course which students take in the third or fourth year of their studies of computer science at Paderborn consists of four hours per week of lectures in a teaching theater with about 100 students and two hours per week of practical training and discussion (tutorials) in small groups with about 15 students. Additionally, the students have to do homework: Every week they have to accomplish some assignments the results of which are the basis for the discussions in the tutorials; to fulfill the assignments is mandatory to pass the course. Depending on the course, the students' results are marked by the teachers and the students get respective feedback.

Teaching and learning, whether it takes place in universities, other institutions or even as an individual activity at home, are almost impossible without the use of media, the most important being pen and paper. In our western society, pen and paper are in principle available to everyone at any time and any place. Additionally, in university teaching a number of other media are used, mainly to support lecturing. Lennon and Maurer discuss the main problems and advantages of conventional media such as black and white boards, flip charts and overhead transparencies [see Lennon & Maurer 1994]. Two typical problems arise when using complementary electronic media in education: the need to change between conventional and electronic documents and their availability at the different learning places.

The typical use in a lecture is as follows: The lecturers prepare the lessons by browsing through books, journals and other documents such as, for instance notes from lectures they have given before. During the preparation, they either take notes on some sheets of paper that are then taken to class to be copied onto the black board or they type the notes into the computer to prepare overhead transparencies which are presented to the students in the teaching theater. During the lecture, the students usually need to write down what is written on the board or presented on the slides. Slides may also be photo-copied and distributed to the students; however, often they are not available to the students during the lecture so that they cannot annotate them while listening to the lecturer.

Obviously, there are some drawbacks with this kind of lecturing technology. One point we want to emphasize here, is the problem of non-continuity in the use of media: There are several changes between the use of paper or board and the use of electronic material. Preparing hand-outs and disseminating them to the students before the lecture starts, is a step into the right direction.

With multimedia being suggested as the new challenge to university teaching, new ways of presenting material arise. Apart from static objects such as text and images it is now possible to also present animated sequences, simulations and movie clips. To discuss the educational concepts—how to best integrate these new media in a way to enhance learning—is beyond the scope of this paper. However, it becomes obvious that new technical problems arise as well. Students must have access to and work with this material in a way comparable to the way they are nowadays working with pen and paper by, e.g., taking notes and annotating the (multimedia) documents. Lennon and Maurer present a lecture scenario that suggests the use of a hypermedia system "in which there is general and specific information, such as collections of examples and solutions, collections of pictures, video and audio clips, and simulation programs" as the core of lecturing technology ([Lennon & Maurer 1994], p. 9). The use of such a system is only reasonable if the material can be accessed and worked upon not only in the lectures and at the students' workplaces in the university but also at their homes and in the classrooms where students are supposed to play a more active role by discussing their assignments and doing practical exercises. Thus, it is not just a hypermedia system but a whole new infrastructure that has to be created.

3 Technical Changes and Educational Consequences

Our research group on "Computers and Society" started with the use of technical media in education in the summer of 1994. One field of our research is to evaluate the scientific interrelation between information and communication technology and its usage context. One of the crucial issues is to identify how and in what way the overall situation will or can be influenced by changes in the methodical or organizational instruments being employed. In particular, we explore the specific quality of technology in relation to social processes of learning. Consequently, we are testing new technical conceptions in our own teaching practice under the conditions of "Alltagspraxis"; i.e. working under realistic conditions with given time constraints and limited resources in the everyday routine [see Brennecke & Keil-Slawik 1995].

Meanwhile we have organized four courses and several seminars employing specific technical equipment. This has changed from merely providing course material through the World Wide Web in summer 1994 to using an integrated teaching and learning environment in summer 1996. Each step was evaluated [see Brennecke & Keil-Slawik 1995] and respective modifications depending on the results of the preceding courses and the new technological possibilities were made. This can be seen as a process of co-evolution, where the technical environment changes, but also the concepts and practice of our teaching.

In what follows, we will outline the essential steps we took. In the first two courses we used the World Wide Web only. In the second two courses we began to build an integrated teaching and learning environment. We will describe the technical innovations we implemented and the new opportunities created by using the teaching environment. We will then go on to show, how the use of this new technical environment influenced changes in the didactic arrangement and our way of teaching. We will also make some remarks about the evaluation of each step and will discuss the advantages and deficiencies.

3.1 Step I: Using the Web

When we began to use the World Wide Web (Web) in education, the Web was not well known by our students. In summer 1994, only 30% had used the Web before. This figure changed over the last two years, from 72% in 1995 to 78% in summer 1996. In 1996 22% of our students had even used Hyper-G before, a 2nd generation hypermedia system which we use now because of its numerous advantages. Meanwhile, the Web has become an integral part of the students' every day work in computer science. With some time delay, this may come true for other disciplines as well. Hence, it can be said that during the last two years hypermedia systems have turned from a specialist's tool to a widely used source of information.

As a first step we used the Web for providing students with course material mainly consisting of texts and graphics. Apart from the ability to access relevant text pages through hyperlinks from graphical or textual overviews there were few advantages as compared to pen and paper. Students appreciated the availability of the material as well as the ability to always work with the last update. Students had access from every computer on the network of the university and could look for new material, read it on screen or make print-outs. However, since the students could obtain the same material by photocopying it, hypertext was "regarded … as an additional reference resource for conventional … teaching materials". This has also has been suggested by [Whalley 1990].

For the teaching staff, the preparation of the material in the Web meant additional work. The texts were automatically converted into the hypertext format needed, but content-related hyperlinks had to be created manually. Although changes of documents could now be easily accomplished, the administration of the course material proved to be a substantial amount of work. For example, there were no tools for version management, and documents could only be structured via the hierarchical file system. With several hundreds of hypertext nodes this was not easy to handle.

The students could only read the electronic documents in the computer rooms of the university. Our evaluation showed that this environment is not suited for working with text material, mainly because of the noise. There was no access to the documents during the lectures and the tutorials which required the frequent change of media between the electronic documents and paper. Thus the material was not really embedded in the course, students were neither forced to use the system nor were they particularly encouraged to do so. It turned out that at the beginning only 36% and at the end 7% of the students used the Web for reading the documents (for more details of the evaluation see [Brennecke & Keil-Slawik 1995]). This correlates with the experience gained in other projects: that multimedia material with no curricular embedding is rarely used; like, e.g., the system VENE, see [Beran et al. 1995].

Furthermore, the material could only be read. Students were not able to create personal hyperlinks or organize the documents in an individual manner apart from setting bookmarks. Annotations to documents were possible, but only in a rudimentary manner. The browser most widely used at that time, Mosaic, allowed the users to create annotations on a per-document basis in an additional file. With the Netscape browser becoming more prominent, the situation became even worse since this browser does not support annotations at all. As a consequence, it can be said that the Web basically was used as a printing-on-demand device for text documents. Nevertheless, the students gave positive feedback for using the Web although they worked largely with the printed material only.

However, for the teachers it became clear that it made no sense to investigate in the construction of hypermedia document bodies with so little advantages for the students and without a curricular embedding. For the innovative use of hypermedia material we had to do more, but under the conditions of "Alltagspraxis" this could only be done in small steps with an evaluation after each step to show the respective advantages and disadvantages and to get a clear picture of the overall costs.

3.2 Step II: Educational Hypermedia

As a next improvement, in the summer of 1995, we used a different hypermedia system called Hyper-G (now HyperWave [see Maurer 1996]), and additional other electronic tools such as email and news to organize the homework of the students. As compared to traditional Web servers, HyperWave offers several crucial advantages. It has different search facilities, i.e. a full text search is implemented, which is very useful to explore the topics of the lecture and to look up certain key words. Searches can also be limited to user-defined parts of the document space. Single documents or collections may be protected with access rights so that, for instance, only registered participants of a lecture get reading access. This allows us to include documents in the system which we are not permitted to publish in general due to copyright constraints. Beyond that, a private area for each student can be established where he or she can file his or her own documents and create a personal view with links to the available documents. For the teachers the basic advantages lie in the administration of the documents. Without installing real copies, different views can be created. On the one hand, documents may be divided and grouped into different categories such as articles published by our research group, articles from other authors, texts of laws, technical standards etc. On the other hand, the same material may be sorted by the different topics of the lecture. Of course HyperWave offers a lot more features which have been described elsewhere [see Maurer 1996].

At the beginning we had provided articles already printed, theses and reports electronically. These long texts could now be better structured by splitting them into smaller parts, building hypertexts, and putting them into collections, the HyperWave equivalent of a directory, with specific titles. "Semantic maps" were constructed, i.e. different parts of the lecture (e.g. the history of computing) were edited graphically and filed in HyperWave as a "clickable map" such that links referred to relevant documents. The creation of these "semantic maps" is certainly expensive because it needs a lot of design effort, but they are very useful because they give an overview and define the semantic space which is to be explored by the students; the concept of semantic maps has been elaborated by [Klemme 1996]. The references are constructed in a way to point directly to the relevant (text) positions. Thus, the students do not need to browse through the whole universe of documents. Due to these specific advantages of electronic teaching material over paper material the students' acceptance of the electronic material could be significantly increased.

As an additional feature, a special newsgroup was installed to provide a forum for discussions beyond lectures and tutorials. Every week the assignments were sent to this newsgroup, but also published in HyperWave. The students were required to work on these exercises in small groups of up to three persons and send their results via email to the tutors. This was our first experiment with electronic delivery of students' homework. The weekly delivery of homework was mandatory for the students (necessary for certification), therefore they were supposed to deal with the electronic lecture notes in a more intensive way than the year before. The exercises were discussed between students and the tutor and partly presented on the blackboard in a normal (i.e. with no electronic equipment) classroom.

Newsgroups were not an integral part of the teaching environment, and were only used by a few people. Amongst technical notes on HyperWave, there was mainly a discussion about the unfavorable situation of having to read on monitors in the noisy and stuffy computer rooms. This situation could be moderated later by providing a local HyperWave database which the students could take home to their PC's. The electronic delivery (via email) of the students' homework did not bring any specific advantage in this phase of development because it was text based only and there was no possibility for a direct presentation in the classroom. For the discussion of the answers these had to be printed and brought on paper and/or needed to be compiled newly on the blackboard (from memory if necessary).

Since the lectures and tutorials were held in rooms without any computer equipment, neither the material filed in HyperWave could be accessed nor the exercises or home work of the students could be presented. The level of integration was very low and there was a lot of unsatisfactory work due to the non-continuity in the use of media. It became apparent that we had to solve these problems in the next step in order to make more efficient use of multimedia technologies.

3.3 Step III: An Integrated Teaching and Learning Environment

An integrated teaching and learning environment is a technical arrangement that provides the use of electronic documents through all phases of teaching and learning. Without such an environment, new documents can only be used for certain limited tasks and will not be able to unfold its full capacities in supporting teaching and learning. While the technical arrangement alone will not be of very much benefit for teaching and learning purposes and will certainly not revolutionize university education—as has been suggested in popular journals—, we will show that the educational process can be significantly improved if an integrated infrastructure can be provided.

Universal access and seamless integration of various document types needed in a course are mandatory requirements for the technical infrastructure. This means that all teaching material, including the slides used by the lecturer have to be integrated into the hypermedia system and should be accessible from all places where teaching takes place. Images which have been taken from books or other sources have to be scanned and converted into a computer-readable format. Nowadays, most slides are produced on computers anyway. However, as it turned out, integrating these slides into the hypermedia system was not as easy as we had assumed in the beginning. Storing each slide in a single PostScript file would consume too much disk space. Alternatively, it would have been possible to simply store all slides as one large PostScript file. But, a number of problems arise then: On the one hand, the amount of disk space needed is still quite substantial. On the other hand, slides stored in that way can only be accessed in a sequential order; random access to a single slide is not possible. Finally we decided to store the slides in two different ways: first, as a single large PostScript file that the students could print-out to have the images ready at hand without access to a computer and second, as a sequence of GIF images in screen resolution and full color for on-line access. At the beginning, these images were prepared manually until a tool had been developed to automatically convert slides prepared with Powerpoint into a sequence of GIF images [see Bollmeyer 1996].

Homework assigned to the students was also published within the hypermedia system. In addition to the provision of course material, the system was also used actively by the students themselves. For that purpose, every student was given an account on the HyperWave server where he or she could store personal material such as his or her homework. They could also build hypertext pages or copy parts of the course material, thereby creating their personal view. Access rights could be set to allow other users or specific groups of users to read documents or modify them.

The integration of personal and public material proved to be very useful. Now, students delivered their exercises within the hypermedia system and could get direct feedback within the same system in the form of commentaries. This greatly reduced the work that had to be done by the tutors. Furthermore new types of assignments could be given to the students: Some tasks required them to write small hypertexts or to visualize the connections between different bodies of text by putting links between the relevant parts; they were also given design tasks where they had to create a small user interface for a small program.

As a consequence, new ways of presenting the students' homework needed to be found. The tutorials were held in our newly established "electronic classroom", a room initially equipped with a computer linked to the internet and with a number of monitors arranged on low racks in a circle, thus allowing face-to-face communication and cooperation. It was now possible for the tutor to ask any of the students to present their homework. Either the students could walk to the tutor's place and do the presentation from there, or they might stay at their own place letting the tutor turn the pages at their command. It turned out, that most of the presentations, each of which normally takes no longer than five minutes, stirred up vivid discussions where any of the other students were able to ask the tutor to show his or her own alternative solution to the task. The different solutions could then be presented side by side and compared to each others.

We then decided to replace the monitors by PC's, each linked to the internet as well as to an "educational network" allowing us to connect any keyboard mouse or screen to any of the computers in the room. With this technical arrangement, students could do their presentations without having the tutor act as a presenter. It was also possible to give full control over each computer to the students sitting in front of it, so that they could browse through their own homework in order to find some arguments or to access the documents provided by the lecturers as background material for the discussion. With this infrastructure, the way of teaching changed from a teacher-centered style to a mixture of working in small groups, discussing with the whole class and presenting homework. Switching from one working mode to another could be done very easily and thus was done quite often. For instance, some students presented their homework and then small groups of two to three students were given a task where they had to use the course material or some documents prepared especially for this lesson. After some time of trying to solve the task, the results were collected, compared, and discussed with the whole group. Additionally, students were able to access their own document space on the hypermedia system to take notes and store them. However, this was only done on very rare occasions by very few students.

4 Conclusion

We have described some stages in setting up a "learning-supporting infrastructure", using it under everyday constrains of limited time and resources ("Alltagspraxis"), and evaluating the factors of success and failure in order to suggest further improvements. Alltagspraxis is a crucial issue here since we were not interested in proving that something can be accomplished in principle, but rather why and under what circumstances the benefits of new media unfold in daily use.

Our basic premise is that learning is an inherently social activity and that human interaction is a crucial factor for successful learning. Hence, we concentrate on questions such as: What kind of technology is conductive to human learning? Where do technical problems create hindrances and obstacles to effective learning processes? What concepts and teaching methods are needed to make best use of the technology available? It is our firm belief that we can only solve technical problems by providing a technical infrastructure; social problems require social solutions, pedagogical problems require pedagogical solutions, etc. However, separating technical and social problems does not imply that they can be treated in isolation. It is rather necessary to specify more precisely in what way they influence each other, and to avoid misleading expectations about the role of technology in teaching and education.

We first started by using the Web which implemented a sort of printing-on-demand facility. We came to recognize that supporting active learning and obeying certain regulatory constrains such as copyright laws would require us to use a more advanced system. By using HyperWave we could satisfy many of the requirements, but created the demand for a better technical infrastructure. We then built up the electronic classroom just to recognize that simple functions such as writing on-line minutes of discussions, for instance, could not be accomplished unless we were able to shut down all monitors except the one of the person who was editing the minutes. Thus, we were continuously upgrading the infrastructure by adding equipment (educational network) and developing new tools to better integrate different kinds of material.

Besides technical and organizational changes we discovered also that our notions and concepts of teaching changed as well. At the beginning we thought of providing a sort of multimedia textbook. Then we came to recognize that our server included more than 1200 documents of different origins and different quality. Rather than creating a multimedia textbook we were creating semantic maps to allow the students to selectively and effectively explore the universe of documents relevant for the respective lecture. We also had to think about new kinds of work assignments which allowed us to check in an effective way whether or not the relevant documents had been used.

New media may help to develop more flexible forms of combining individual and social learning processes. They may help to develop new kinds of (multimedia) material and cut down costs of accessing and distributing it. It turns out however, that the benefits provided by new technology can only unfold when it is appropriately embedded in a social setting where new pedagogical concepts and organizational settings provide the essential framework for learning.

5 References

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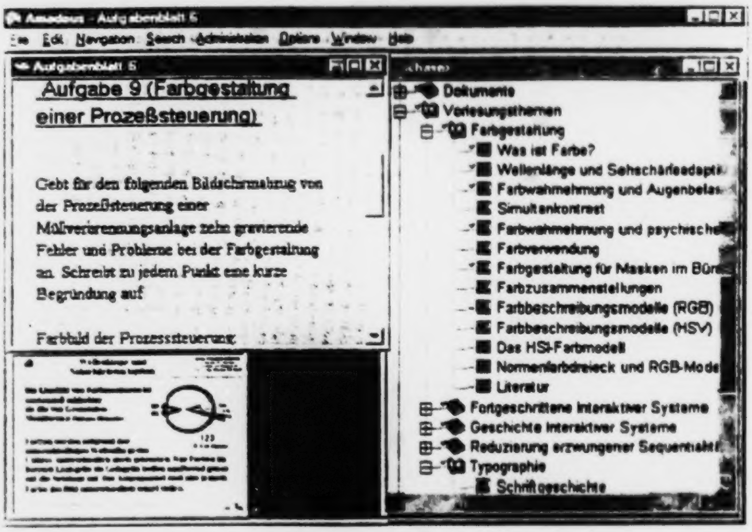
6 Appendix

The following figures give an impression of the way our technical infrastructure supported the various phases of teaching and learning. The examples are taken from the course "Designing Interactive Systems" which is a third-year course attended by about 100 students. Four hours of lectures and two hours of tutorials are given per week. This particular course has been given for the second time and was held in the winter term 1995/1996.


Amadeus - Aufgabenblatt 6
File Edit Navigation Search Administration Options Window Help
Aufgabenblatt 6
Dokumente
Vorlesungsthemen
Farbgestaltung
Was ist Farbe?
Wellenlänge und Sehschärfeadapt
Farbwahrnehmung und Augenbelas
Simultankontrast
Farbwahrnehmung und psychische
Farbverwendung
Farbgestaltung für Masken im Bür
Farbzusammenstellungen
Farbbeschreibungsmodelle (RGB)
Farbbeschreibungsmodelle (HSV)
Das HSI-Farbmodell
Normenfarbdreieck und RGB-Mode
Literatur
Fortgeschrittene Interaktiver Systeme
Geschichte interaktiver Systeme
Reduzierung erzwungener Sequentialit
Typographie
Schriftgeschichte

Aufgabe 9 (Farbgestaltung einer Prozeßsteuerung)

Gebt für den folgenden Bildschirmabzug von der Prozeßsteuerung einer Müllverbrennungsanlage zehn gravierende Fehler und Probleme bei der Farbgestaltung an. Schreibt zu jedem Punkt eine kurze Begründung auf

Farbbild der Prozesssteuerung

Figure 1: HyperWave's PC-client Amadeus with the collection overview (at the right side) and some course material (at the left side).

The first figure [Fig. 1] shows a part of the documents we provided for the course as they present themselves when using HyperWave's PC-client Amadeus. On the right-hand side, an overview of the collections of documents can be seen. In this view, these are structured according to the topics of the lecture but other views are available and can be created individually. Among those documents, you will find articles from scientific journals and conferences, the text of certain laws and ISO standards, notes and overviews prepared by the lecturers, as well as slides that have been presented during the lectures. The open collection "Farbgestaltung" (which addresses the issue of how to use colors in the design of interactive systems), contains a number of such slides—one example is shown in the bottom left corner of the figure. Not all of the documents, in particular the slides, are "handed out" at the beginning of the term; the body of material grows from week to week. This is one of the reasons, why CD-ROMs cannot be used in this scenario. In the top left corner of the figure another kind of document can be seen: This is a homework assigned to the students.

The second figure [Fig. 2] shows the view onto some material that one of our students has prepared. In the bottom left corner, you can again see some collections; this is a part from this student's private workspace. The worksheets, here no. 6, are available in hypertext as well as in Postscript format and can thus be easily printed. Within the same collection, there is a picture–shown in the upper left corner. The particular exercise was to find the main problems concerning the use of colors in the application from which this screenshot has been taken. The student's solution to the exercise is given on the right-hand side. The students have linked their argumentation to specific parts of the picture to illustrate the problematic items. It should be noted, that the workspace shown here is in fact shared by a group of two to four students cooperating in solving the exercises. However, every student also has an individual workspace in addition to that. In the bottom line of the collection browser, a document "Punktewertung" can be seen. In this document the tutors give comments to the solution and assign credits. As you might have guessed, that document can only be written by the tutors and is readable only by the students within that small group.

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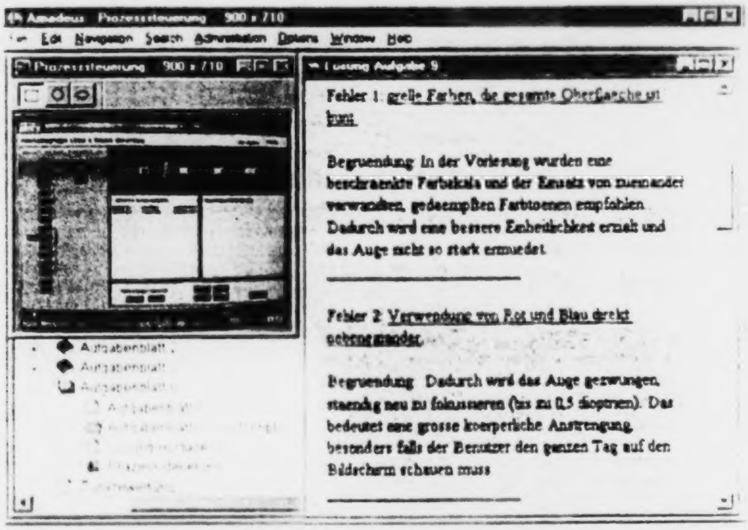

Amadeus Prozesssteuerung 900 x 710
Edit Navigation Search Administration Options Window Help
Prozesssteuerung 900 x 710
Loesung Aufgabe 9
Aufgabenblatt
Aufgabenblatt
Aufgabenblatt

Fehler 1: grelle Farben, die gesamte Oberflaeche ist bunt.

Begruendung: In der Vorlesung wurden eine beschraenkte Farbskala und der Einsatz von zueinander verwandten, gedaempften Farbtoenen empfohlen. Dadurch wird eine bessere Einheitlichkeit erzielt und das Auge nicht so stark ermuedet.

Fehler 2: Verwendung von Rot und Blau direkt nebeneinander.

Begruendung: Dadurch wird das Auge gezwungen, staendig neu zu fokussieren (bis zu 0,5 dioptrien). Das bedeutet eine grosse koerperliche Anstrengung, besonders falls der Benutzer den ganzen Tag auf den Bildschirm schauen muss.

Figure 2: HyperWave's PC-client Amadeus with an example where students have to criticize the use of color in the design of an interactive system.

Having all course material available within the hypermedia system, the problem is that we need an access to that material in the tutorials. There the students' solutions are to be discussed, the background material as well as the slides should be at hand as a reference in those discussions. This is achieved by using the electronic classroom which is shown in the third figure [Fig. 3]. The use of low racks for the computers guarantees that discussions are not disturbed by obstructing the view. Each of the computers can be projected onto the large electronic whiteboard and also onto the other monitors. While the first way of projection allows to focus the students' attention better, the second way is preferred by most tutors because discussions tend to be less centered around the tutor. However, the appropriate method can be chosen by the lecturer at any point in class. In our courses, most of the time in the tutorials is spent on discussing the students' homework, where we can easily turn over the control of the computers to those students who want to present their solutions. Depending on the topic to be covered in the tutorial, we also assign tasks to be solved by small groups during the exercise; the results—sometimes a small hypertext, sometimes the results of an internet search—are discussed in class afterwards.

Figure 3: The electronic classroom with the arrangement of monitors and the electronic whiteboard.

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Hypertext And Semantic Nets: Experiences With Modular Authoring

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Abstract: This article discusses the usability of semantic nets in modular design and writing, as experienced by authors in four test projects. Findings show the importance of clear agreement on the semantics of graphical networks used to describe content structure. The choice of semantics also relates to the effort involved in writing node texts modularly, keeping contextual references and transitional phrases to a minimum. Since such phrases can be important in learning however, some directions are proposed to accommodate for these in a modular setting. (Extended version of this paper is on the confrence cd-rom).

Introduction

Computer Supported Hypertext Authoring

To improve the way in which learning material can be revised, re-used and recombined, the Open university of the Netherlands developed ILCE, a computer based Interactive Learning and Course development Environment [Valcke & Vuist 95], [Brok 95]). This current article focuses on how authors use networks to (re)organise modular text in ILCE. For an account of student experiences see [Martens et al. In press].

The ILCE system supports a top-down course design method. Course designers define a *content model* which is to represent the structure of the content matter as a network [Fig. 1].

Each network node represents a certain subject. Also each node has an internal substructure of sections on the subject, like 'example' and 'exercise'. Subsequently, authors elaborate each node section into actual text, graphics, animation or any other type of media clip. Authors assign attributes to each node (section) to specify conditions (e.g. for which type of student the section will be appropriate).

After a repository of learning material is thus produced, the course team can specify a student (population) profile so the system will automatically select an appropriate and consistent subset of node sections. The selected learning material is delivered in printed and/or electronic format.

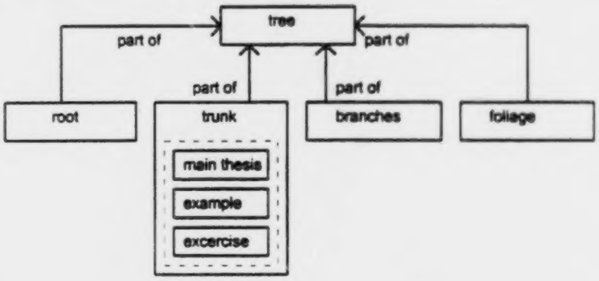

Figure 1: An ILCE content model.

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Hypertext And Narration

An increasingly acknowledged distinction between hypertexts is between narratives and collections (e.g. [Gloor 90]). In an educational setting, we can speak of teacher stance versus discovery stance respectively [Brok & Martens In press]. Since no human teacher is present in distance education (and many computer based training), all coaching of the learning process should be in the material itself and therefore takes on a teacher stance. This has important repercussions for modular authoring.

In discovery-stance hypertexts, separate articles can easily be written by different authors from different perspectives. Moreover, there is no need for a narrative connection between articles. In teacher-stance hypertexts however, the reader expects a well-structured narrative line, in which arguments are gradually developed. The reader also expects the text to speak with one voice, consistent in style and content. These demands are difficult to meet if the presented material is dynamically selected from a broad collection of content nodes.

On the other hand, when authors produce hypertext versions of existing text books, consistent style will be assured, but careful editing will be needed to tailor the texts for highly modular use. Existing material can be hard to use as a basis for publishing customised versions. For large text bases, automated text to hypertext conversion is highly desirable but often results in less meaningful structures than hand conversion [Riner 91].

Relating Hypertext To Semantic Nets

A semantic net [Fig. 2] consists of nodes and links, and is used to express the semantic structure of a certain subject domain. Each node identifies an object (class) in the domain, and the links represent semantic relationship between nodes.

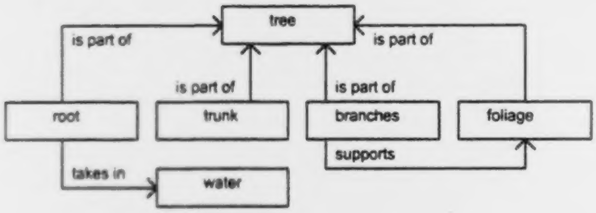

Figure 2: A simple semantic network.

Given the structural similarity between hypertext and semantic nets, it is often proposed that (re)organisation of texts into modular hypertext, should be mediated by defining a semantic net (e.g. [Rada 90]). Mapping semantic nets directly onto hypertext structure is not straightforward however and has been the subject of considerable debate (e.g. [Jonassen & Mandl 90]).

There are some important properties of a semantic network to note. In genuine semantic nets, the meaning of a node lies solely in the relationships with other nodes, not inside the node itself. In hypertext however, the nodes contain abundant subject material; the links serve primarily as navigational aids instead of expressions to assign meaning to the node contents.

Another important property of genuine semantic nets, is that they are not biased to a certain usage, for example the order in which the nodes are to be traversed in a reading or teaching session. This same attribute is claimed to be an important attribute of hypertext but, as discussed, is often hard to realise in practice.

Several interesting alternative approaches were proposed to relate networks to hypertext structure. [Chaoui et al. 92] propose a distinction between structure links and semantic links in their hypertext network. This can be perceived as a way to combine narrative links with genuine semantic links.

[Rada 90] proposes to project hypertext nodes (paragraphs) onto links (node-link-node triples) in the semantic net instead of simply onto nodes. This approach should be very feasible, since each link in a genuine semantic net asserts a certain statement, which is easily elaborated in a textual treatment of that statement.

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Semantics Of Content Models

There are many ways to design and interpret a ILCE network which represents study content. Imagine a science course on global heating. [Fig. 3] shows a section of the content model. What does this model exactly *mean*?

- In the domain, after each occurrence of the phenomenon 'a storm', there will be an occurrence of the phenomenon 'a calm'.
- In the course, the subject 'a calm' should always be treated after the subject 'a storm'.
- In the course material, the text called 'calm' will be appended to the text called 'storm'.

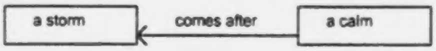

Figure 3: 'After a storm comes a calm'.

Note, these interpretations are fundamentally different. The first interpretation takes the model to describe the structure of *the subject domain* itself, regardless the order in which the subject is to be treated in an educational session. In such cases we can speak of a genuine semantic network.

The second interpretation takes the network to describe the structure of *the narrative or educational discourse*. In such cases we will speak of a discourse network. The third interpretation is very related to discourse, but actually refers to specific pieces of learning material instead of concepts. In such cases we will speak of a document network.

The difference between semantic and discourse networks is elemental (e.g. [Wenger 87], p. 13-25; [Lesgold 87], [Chaoui et al. 92]), but in practice, domain structure and discourse structure tend to match. Differences will become apparent however, when network grain is fairly detailed while nodes are elaborated into texts. If the science course expresses the fact that 'a tree consists of root, trunk, branches and foliage', a fairly detailed semantic network would express this fact as in figure [Fig. 4]a.

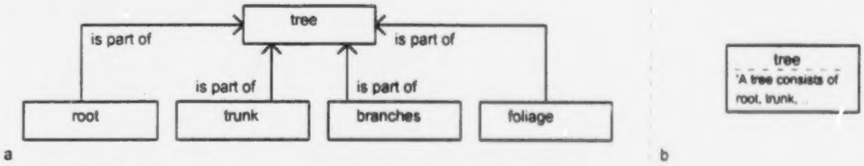

Figure 4: A semantic network (a) and a document network (b) expressing the same fact.

In a discourse or document network however [Fig. 4]b, the same fact would be expressed in a single node, treating the subject 'tree'. *Only when* there are also separate treatments on root, trunk, branches and foliage, there is need for other nodes accordingly. A semantic network needs to be fairly detailed, to properly express all subject knowledge in the network structure. In a discourse network, nodes are only distinguished as far as they will be elaborated into separate treatments.

Since constructing a network based on semantics is a very difficult task for a large document ([Chaoui et al. 92]), such as a book, a discourse/document network approach might be more feasible for organizing large repositories.

Summing up, in semantic networks subject knowledge is represented in the network structure whereas in discourse or document networks subject knowledge is in the node contents. [Fig. 6] offers an overview of this issue.

	network structure	node contents	relationships
semantic network	describes domain structure	none or redundant	e.g. - is a - causes - is above
discourse/ document network	describes discourse/ document structure	describes domain	e.g. - summary of - explains - prerequisite of

Figure 6: Differences between semantic networks and discourse or document networks.

Relationship Types

[Fig. 6] also shows how semantic networks typically exploit other types of relationships than discourse networks. As mentioned ([Fig. 1]), ILCE resolves typical discourse relationships (like 'example of) in the *internal* structure of nodes. So *between* nodes, we would expect a discourse network in ILCE to exploit much less different relationships than a semantic network.

Research Questions

We empirically investigated how authors used ILCE content models to organise educational hypertexts:
- which type of network semantics (semantic/discourse/document) do authors use spontaneously?
- which type of links do they use most frequent?
- how does choice of network semantics relate to easy elaboration of node content?

Method

Test Projects

Prototype versions of the ILCE system were used on an experimental basis in four course teams. Study subjects were law, math, statistics and multimedia. In each team, two course designers/authors used the system to design a content model and (except for one team) elaborated nodes into text. Several hundreds of text pages were reorganised this way, and were studied afterward by students for evaluation [Martens et al. In press].

Procedure

During the first year of investigation several methods were used to gather author responses.
Interviews. Soon after authors had acquainted themselves with the ILCE system, three of them were interviewed.
Plenary meetings. During the year, there were regular meetings in which experiences were exchanged.
Survey. After they had extensive experience with the ILCE system, five authors filled out a questionnaire.
The survey featured about 100 questions, concerning:
- the course development method which ILCE was to support;
- the structural design of the ILCE system as a cognitive tool;
- the technical performance and local user interface details.

This article will only report on questions regarding modular writing and the use of networks.

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Results

Appreciation. In general, authors expressed very positive opinions about the structured design method. They stated the system makes them think very systematically about course content and structure, spelling out design choices that would be left implicit otherwise [Brok & Martens In press].

Mixing styles. Our investigation showed, that in practice most authors spontaneously produced hybrid content models, interweaving discourse/document - and semantic structure. Most relationships structure educational discourse; only some exist in the subject domain.

Overall, authors did not run into problems mixing these styles, since discourse structure and domain structure often matched to a large extend. This was probably because most authors converted existing courses. Some relationships could be easily misinterpreted by other authors however, such as 'follows after'.

Relationship types. As discourse networks tend to exploit few different relationship types, authors only used about three types for most of the links.

Hierarchy. To balance larger and smaller nodes, authors tended to organise the network as a tree, with large nodes branching into smaller nodes, as in a table of contents. Note, this was a significant move away from viewing the content model as a semantic network, unbiased to any narrative ordering.

Network semantics and writing. Our main observation was, that nodes in discourse networks were far more easy to elaborate into texts than nodes in genuine semantic nets. One author specifically reported he failed to assign texts to nodes of a fine grain semantic net and changed to a rough grain discourse network instead.

Authors expressed they need to have a specific node order in mind while writing the separate texts. Some found it hard to write on a general concept regardless the context. These authors preferred to write separate texts for each context, differing in perspective but largely common in content. Separating general paragraphs from example applications in existing text books, required much more editing than expected. The original text book also featured cases continuing through multiple subjects, which posed some problems for modular delivery.

Questionnaire Results

[Tab. 1] shows mean scores for item clusters, concerning content model design and modular authoring. Respondents expressed moderate opinions on the ease of designing and editing a content model (*model*). They reported no problems in choosing and assigning relationships between nodes (*relations*). The option of assigning levels (e.g. 'section', 'chapter') to nodes was regarded useful and easy to work with (*levels*). Adding content texts to nodes proved much harder (*nodes*). Respondents expressed modular writing was quite hard to put into practice (*writing*). In response of one overall question, respondents were fairly positive about the course design method altogether (*overall*).

	issue	*number of questions*	*mean (1-5)*	*s.d. among subjects*
model	Ease of designing/editing content model	2	3.38	0.77
relations	Ease of assigning relationships	3	3.64	1.16
levels	Ease of assigning levels to nodes	2	3.88	1.34
nodes	Ease of adding content to nodes	1	2,50	1,29
writing	Ease of modular writing	2	1.75	0.87
overall	Overall positive on the design method	1	3.75	0.50

Table 1: Questionnaire results: content model design and elaboration.

Conclusions And Recommendations

Network semantics. Authors intermingled domain and discourse/document relationship types, with a strong preference for the latter. However most authors didn't report any trouble with these mixed styles, we expect serious confusion when content networks will be used or elaborated by people other than the original creators.

Discourse/document networks proved far more easy to elaborate into texts than genuine semantic nets. Authors welcomed the option to assign hierarchical levels to nodes, such as 'chapter' and 'unit', which explicitly stresses the preference for discourse structure.

Flexible reuse Using a document network (instead of a semantic net) is far from a drawback in itself, but may restrict the flexible (re)use of material. The authors tended to design one fixed learning path, customised by optional and alternate texts. Alternative orderings would call for many adaptations in texts.

Modular writing. Writing is an activity in context. Authors find it hard to write actual texts with little knowledge about the context in which students will study it.

Without narrative transition phrases, like 'thus' and 'as we have seen', students may fail to understand the link between text parts. A possible solution would be to distinguish *link nodes* from *content nodes*. Content nodes should be written generally, to be used as part of any course. Course-specific link nodes would introduce a content node (set) to the student, with a narrative explaining the relationship with prior issues and the role within the course as a whole. This way, students will also accept style and perspective shifts between content nodes.

All in all, we learned it is much more easy for authors to use systems like ILCE as an advanced hypertext document management system, rather than a knowledge representation tool. Nevertheless, computer supported course design, production and delivery was welcomed very positive by the authors involved.

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Concept-based Navigation in Educational Hypermedia and its Implementation on WWW

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Abstract: This paper is centered around concept-based navigation, a powerful hypermedia navigation model. Main ideas behind concept-based navigation model are concept-based indexing and student modeling. We introduce the idea of concept-based navigation and describe its implementation in InterBook, an authoring system for designing Web-based adaptive hypermedia. We also demonstrate a number of benefits of the approach itself and its implementation in InterBook.

Introduction

Classic navigation model in hypermedia is page-to-page navigation using links between pages. This paper suggests and describes a more powerful navigation model which we call concept-based navigation. Main ideas behind concept-based navigation model are concept-based indexing and student modeling. Concept-based indexing is used to provide additional information about the content of each hypermedia page by indexing it with related domain concepts. In this context, by domain concepts we mean atomic pieces of knowledge in a given domain. Student modeling is used to represent the state of the student knowledge about domain concepts.

A hypermedia page in a system which uses indexing and student modeling is no longer a black box to the hypermedia server. Indexing tells which pieces of domain knowledge stand behind the page and student modeling tells how well the student is familiar with these pieces of knowledge. This additional knowledge turns a hypermedia system into a knowledge-based system. Including additional knowledge into regular hypermedia pages opens several ways for increasing functionality of a hypermedia system such as adaptive navigation support, adaptive guidance, intelligent help, and concept-based navigation.

We have implemented adaptive navigation support, adaptive guidance, and intelligent help in ELM-ART, a Web-based Intelligent Tutor for LISP [Schwarz, Brusilovsky & Weber 1996]. In our recent system InterBook [Brusilovsky, Schwarz & Weber 1996], an authoring system for designing Web-based adaptive hypermedia we have implemented all the above techniques adding concept-based navigation. This paper is centered around concept-based navigation. We describe special aspects of the implementation of concept-based navigation in InterBook and demonstrate a number of benefits of the approach itself and its implementation.

Background: Indexing in Educational Systems

Indexing was originally suggested in Computer Assisted Instruction (CAI) context by Osin [Osin 1976] who suggested a framework for indexing CAI frames by a set of topics which it covers. Such indexed sets of frames were not related to any pre-scribed order of presentation. They can be accumulated, stored in special libraries, and re-used by different authors to create their own courses. In the multimedia field, a similar idea of a re-usable database of multimedia learning material indexed by topics and keywords is elaborated by Olimpo et al. [Olimpo et al. 1990].

Later indexing was applied in hypermedia and ITS authoring area. In the hypermedia authoring area, an idea of indexing was elaborated by Mayes, Kibby and Watson [Mayes, Kibby & Watson 1988] in the StrathTutor system. They stressed additional preference of indexing the frames of learning material - the possibility to indicate related pairs of frames not by tedious glossary linking of pieces of learning material together, but dynamically, on the basis of similarity of corresponded sets of topics. In the ITS authoring area, indexing was applied to turn traditional CAI into a "slightly intelligent" ICAI [Elsom-Cook & O'Malley 1990; Grandbastien & Gavignet 1994; Vassileva 1992]. "Slightly intelligent" ICAI are based on both the CAI and ITS paradigms.

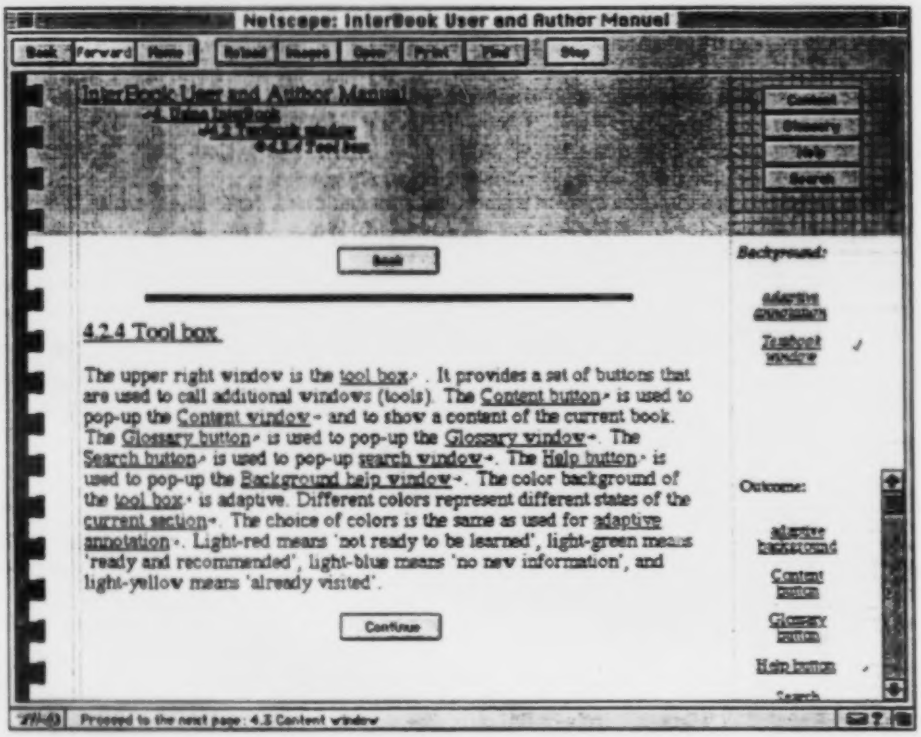
The teaching material is not generated as in 'orthodox' ITS, but stored in CAI-like frames. However, these frames are indexed with the concepts from an explicit domain model network, so they can be selected intelligently.

The most recent application of indexing on the crossroads of the above directions is hypermedia-based ITS which uses the indexing technology to connect the learning material represented in hypermedia form with the domain knowledge base. One of the first hypermedia-based ITS HITS [Tang, Barden & Clifton 1990] separates authoring of teaching material (creating hyperbooks) and course design. The duty of the course designer is designing a syllabus (a hierarchy of subjects with topics attached to it), to choose the hyperbooks to be used and to specify the goal level of student knowledge (in terms of the student model). HITS will manage the course itself, selecting or suggesting the relevant information and tests from the chosen hyperbooks according the syllabus. More recent hypermedia-based ITS are SHIVA [Zeiliger 1993], ITEM/PG and ISIS-Tutor [Brusilovsky, Pesin & Zyryanov 1993].

Concept-based navigation in InterBook

Indexing

InterBook represents educational material as a set of electronic textbooks (ET). An electronic textbook is hierarchically structured into units of different level: chapters, sections, and subsections. Several ET on the same subject form a bookshelf. All books from the same bookshelf are indexed by the same set of domain concepts. This set of domain concepts forms a domain model for the given subject. InterBook uses role-based indexing as suggested by Osin [Osin 1976]. Each terminal unit has an attached list of related concepts (we call this list *spectrum* of the unit) representing a name and a role of each concept in the unit. InterBook mainly supports two roles: outcome concepts and background concepts. A concept is included in the spectrum of a page as an outcome concept, if some part of this page presents the piece of knowledge designated by the concept. A concept is included into the spectrum as a background concept, if a student has to know this concept to understand the content of the page. These two roles have been shown to be sufficient in many contexts [Brusilovsky 1992; Capell & Dannenberg 1993].


Netscape: InterBook User and Author Manual
Back
Forward
Home
Reload
Images
Open
Print
Find
Stop
InterBook User and Author Manual
4.2.4 Tool box
Content
Glossary
Help
Search
Back
Background:
adaptive annotation
Textbook window
Outcome:
adaptive background
Content button
Glossary button
Help button
Search
Continue
Proceed to the next page: 4.3 Content window

4.2.4 Tool box

The upper right window is the tool box. It provides a set of buttons that are used to call additional windows (tools). The Content button is used to pop-up the Content window and to show a content of the current book. The Glossary button is used to pop-up the Glossary window. The Search button is used to pop-up search window. The Help button is used to pop-up the Background help window. The color background of the tool box is adaptive. Different colors represent different states of the current section. The choice of colors is the same as used for adaptive annotation. Light-red means 'not ready to be learned', light-green means 'ready and recommended', light-blue means 'no new information', and light-yellow means 'already visited'.

Figure 1: The main window of the textbook. The index is visualized at the right-hand side.

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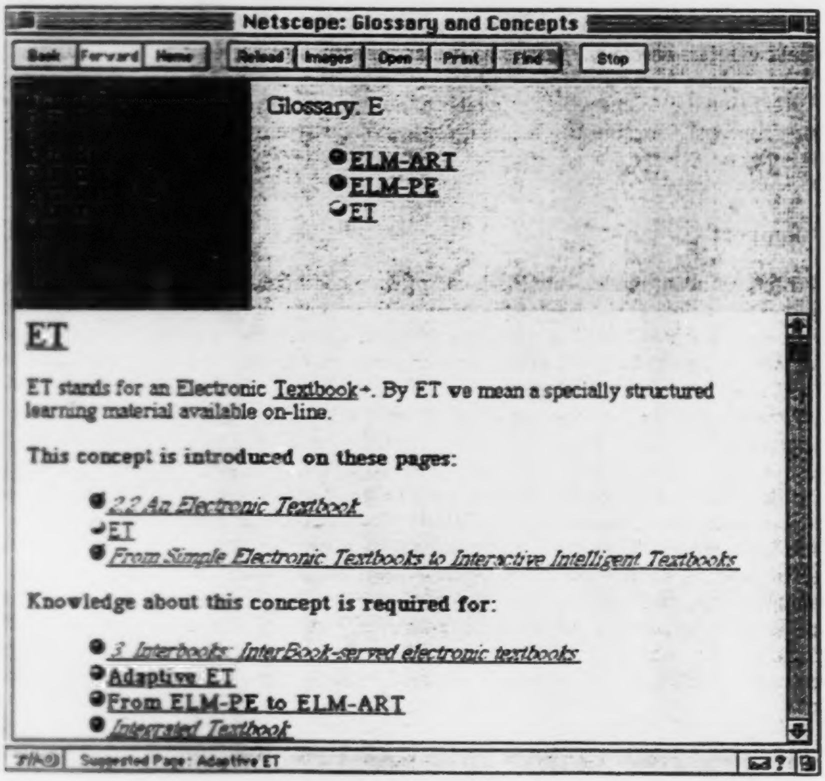
Student modeling

To represent individual user's knowledge InterBook uses an *overlay student model*. For each domain model concept, an overlay model stores a value which is an estimation of the user knowledge level of this concept (for example, unlearned, learned, and well-learned). This type of model is powerful and flexible: it can measure independently the user's knowledge of different topics. Student model and spectrum of a unit can be used to determine an educational state of the unit, for example, is it not ready to be learned (if it has unlearned concepts among its background concepts), ready to be learned (if all its background concepts are learned), or "nothing new" (if all its outcome concepts are well-learned).

The spectrum of a unit is also used to update the student model. When the user completes a unit (either a presentation or testing one) the "knowledge levels" for all concepts of the unit's spectrum are updated. The overall score of total knowledge is computed by adding factors like pure reading experience and passing or failing tests. Structure and algorithms for doing that are not important at this point and will not be discussed here.

Conventional navigation tools

InterBook provides a student with several popular navigation tools such as table of content, search, or navigation bar. These tools are used in a number of electronic textbooks. A specific feature of InterBook is that no authoring of these tools is required: everything is generated by the system. Each navigation tool presents some structured list of unit names which can be user for navigation (naturally, all names are clickable links). Table of content represents a hierarchy of units. Search tool lets a student find all units which contains a specific text. Navigation bar [Fig. 1] shows names of all direct predecessors and all brothers of current unit. It provides an orientation support ("where am I?") and an easy way to move "up", "left", and "right" within the three of units.



Glossary: E

- ELM-ART
- ELM-PE
- ET

ET

ET stands for an Electronic Textbook+. By ET we mean a specially structured learning material available on-line.

This concept is introduced on these pages:

- *2.2 An Electronic Textbook*
- ET
- *From Simple Electronic Textbooks to Interactive Intelligent Textbooks*

Knowledge about this concept is required for:

- *3 Interbooks: InterBook-served electronic textbooks*
- Adaptive ET
- From ELM-PE to ELM-ART
- *Integrated Textbook*

Figure 2: The glossary window displays a short description of the referred concept. Below this description pages and concepts are listed which either require or teach the current concept.

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Concept-based navigation tools

In addition to regular navigation tools InterBook provides some concept-based tools. First of all, InterBook is able to construct a glossary of all domain concepts. Glossary is shown in a special Glossary window [Fig. 2] which contains an interface for locating a concept by its name. For each concept InterBook shows its description (if provided by an author) and generates links to all units which has this concept in its spectrum either as a background or outcome concept. In this sense, glossary in InterBook unifies the features of two classic tools glossary and index.

Second, InterBook generates a concept bar for each unit [Fig. 1]. Concept bar shows clearly all background and outcome concepts for the unit. For a terminal unit, these concepts are taken from its spectrum. For a higher level unit, the list of background and outcome concepts is generated from the respective lists of its subunits. The outcome of any subunit is an outcome of the section, whilst prerequisites are only inherited from the subunits, if they are not tought within another subunit of the same section. This mechanism ensures that a student is always able to see the real educational closure of a section. We decided to show background and outcome of a section in two different parts or frames. Outcome and background are scrollable independently to asure fast access of both of them.

Additional links from the text of a unit to glossary concepts are generated based upon the concept names. These automatically generated links point to the glossary window, where the student, as described, has access to other units which deal with that concept. Links to concepts from the text of a unit are annotated according to their role on the current page. Each link indicates whether the marked concept is an outcome concept, part of the background or just a reference to some concept without a certain role. Further InterBook allows for references to other pages, that might appear within the text.

With concept-based indexing, InterBook can build a naturally structured and tightly interlinked hyperspace of educational material, which supports advanced navigation. For example, a student can start from a unit which describes several concepts, then move to a glossary page which describes one of these concepts. If the student still cannot completely understand the concept, he or she can navigate to one of the units presenting this concept (i.e. having the concept as an outcome concept in the spectrum) which provide some example for the concept. Then the student can select one of the problems related with the concept to test the obtained knowledge. If the problem appears to be hard, the student can analyze the list of background concepts in the problem spectrum and move from a problem to the another concept which is not clear yet (and which can be far away in the network from the starting concept). Thus the user has many ways of navigation and many paths going from the current node to related nodes.

Navigation support

With its overlay student model, InterBook can provide additional help to a student in a form of adaptive navigation support [Brusilovsky 1996]. InterBook uses three main ways of adaptive navigation support. First, InterBook shows an educational status of each unit by marking each link to the unit with a colored icon. Each link to the unit is annotated in that way in all contexts where this link is shown: in the table of content, in the search list, in the navigation bar, etc. Different colors and icons represent different educational status. For example, "red" means not ready-to-be-learned and "white" means nothing new. Checkmarks indicate visited pages. The same color is used to indicate the status of the current unit page either by colored bars or colored backgrounds for concepts. Second, InterBook can provide background help on demand by showing an adaptively sorted list of pages which introduce background knowledge of the current unit. These two ways of adaptive navigation support described in more details in [Brusilovsky, Schwarz & Weber 1996].

Third, InterBook shows the user's knowledge level for each concept represented in the concept bar by attaching icons of different size to concept names. No annotation means "unknown", small check mark means "known" (learning started), medium check mark means "learned", and big check mark means "well-learned". Red exclamation marks indicate concepts on which the student recently failed in solving a problem. In fact, what is shown to the student is the state of the student model. Such a technique is usually called visible student model. A specific feature if InterBook is that visible student model is used for orientation and navigation support.

Discussion: Benefits of Concept-Based Navigation

Visualization of indexing

We consider the visualization of indexing as an important technique. Our philosophy of books, chapters and sections having their own internal didactic structure, which should not be broken without any significant reason, lead us to visualize not only the content of the current page, but the content of the current section as well. InterBook provides navigation support not only for terminal pages, but also for books, chapters, and sections. This enables students not only to select page-by-page their own individual learning paths, but also to select larger units like section and chapter that will bring him to his individual learning goal.

We decided to implement some textual visualization in an old-fashioned hypertext style [Fig. 1]. We took into account that those interfaces are less transparent for novices, but the advantages exceed this problem: textual representation in lists take much less space than graphical one. The required space can be even collapsed, since it a quite easy to generate scrollable lists, which, of course, demand some basic skills on the user's side. Additionally textual representation can be easily extended with adaptive visual cues. Last but not least, old-fashioned techniques like hyperlinks are more transparent in usage and better known to more users.

Visualizing state of knowledge

It is important that in InterBook an implicit feedback about the state of each unit in adaptive hypermedia is represented by either adding visual cues to a link to that unit. A student that is looking for a strong support will work perfectly with such summarizing cues. For more advanced users this could be unsatisfying, because the navigation aids on a higher level of InterBook do just provide suggestions, but can't help with reasons for these suggestions. A page may be suggested because it introduces some very basic competely new concepts to the student or because it just talks about some concept of minor interests, whilst all other concepts are already well-known.

By annotating all concepts with adaptive checkmarks the student can gain an overview about the content of each page quicker [Fig. 1]. He or she can notice by looking at the annotations which are the missing concepts for a page or what really new can be learned on that pageand why it might be unnecessary to read it, because almost all concepts are already known.

Visualizing Relationshios between Units and Concepts

The logical next step of visualizing indexing information is taken by showing information about the current educational relationships between units and concepts. Some approaches use orientation maps, which are represented by a graph. These maps show pages as nodes and one or several concepts as edges [Capell & Dannenberg 1993]. Because these graphical ways of visualizing use a lot of space on the screen, they become completely insufficient in very complex learning environments with many sections and relationships.

Again we decided for some old-fashioned way of common hypermedia pages with simple hypermedia links. We put each of the edges and the nodes of the graph on a single page. As we did see in the last section, nodes are given by the text pages itself with visualized adaptive index. By showing the links in the visualized index the student can reach a concept page in the glossary [Fig. 1]. Such a concept page can be considered as an intelligent copy of an index entry in a common printed textbook. It shortly introduces the concept the page referes to and gives links to all pages where the concept can be learned, i.e. it is an outcome of the page, and for which pages it can be useful, i.e. it is part of the background [Fig. 2]. From this page the student can understand how the information flows through this concept. By this two-way navigation system implemented in InterBook the student is not provided with a general overview like in graphical representation, but he or she can follow information flow forward and backward in his or her textbook to understand the didactic relationships of current page and its conceptual environment. We get away from simple visualization of relationships towards real understanding of them, which should be the final goal of any teaching operation.

Conclusion

Concep-based navigation extends functionality of educational hypermedia systems. This approach is based on concept-based indexing and student modeling which show to be relatively cheap and useful technologies for authoring "more intelligent" hypermedia systems. We have described an implementation of concept-based navigation in our InterBook system for authoring Web-based hypermedia and argued for several benefits of this approach. We hope that our ideas will be usefulf for researchers in the field of educational hypermedia and that our tool will be useful for practioners who are interested to extend their hypermedia systems with advanced way of navigation and adaptive navigation support.

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What Use Are Reviews? An Analysis of Multimedia Information Software Reviews and Their Relevance to Home Information Consumers

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Abstract: Multimedia information systems are a valuable resource for home information consumers. Users need to be able to make informed decisions about the quality and suitability, for their needs, of products which they are considering purchasing. Reviews in print and electronic form are likely to be the primary source of information. This paper examines the relevance of review articles and reports on a study undertaken to assess the criteria used by reviewers when evaluating products. It also compares those criteria with the criteria used by home users when evaluating products which they have already purchased. The development of a transferable methodology which would assist in the evaluation of review information provision in other domains (e.g. schools and libraries) is discussed.

Background

A previous study of home users of information CD-ROM products undertaken by [Gillham & Buckner 1996] investigated user behaviour with these products and examined their perceptions of various evaluation criteria. There were anomalies between the users' stated priorities and their observed actions. The most important stated priorities were dominated by those aspects of using multimedia products which might be seen to be academically related i.e. searching, browsing and accessing textual information. Observations of the users interacting with their systems (which, by the very fact of being observations, may have influenced behaviour) indicated that users actually preferred looking at the multimedia aspects of the information products. Thus, when making decisions as to which information products to purchase users are faced with numerous decisions regarding which criteria are of most significance in relation to their needs. Supposing that users can articulate their need they are then faced with the problem of obtaining information about the products prior to making decisions about purchase.

Because of the nature of new media compared with traditional print sources it is difficult for the potential purchaser to gain an accurate picture of the product. The publishers' marketing information is an obvious source of information but purchasers may regard this information as biased and may seek a more independent opinion of the products. Thus, reviews in magazines, journals or electronic media may be the main way in which information is received about products. To complement our understanding of users' needs and stated preferences the authors have undertaken a further study of review texts.

Relevance of Marketing Information

Advertising material for CD-ROM information products tends to be more limited in the general computing press than that which is available for hardware products. Potential purchasers would have to be fairly focused in their search for advertising information on a particular product. Even supposing sufficient advertising literature was easily accessible we might question the value of this for comparison of similar products. In their advertising literature publishers tend to focus on the perceived motivation of users such as achievement, power, family fun, desire to be accepted, and others identified by [Durgee 1991] in his analysis of Dichter's Handbook of Consumer Motivations (1964). However, there is little evidence that consumers can effectively utilise advertisements in making comparisons between the suitability of those products to their individual or family requirements. Further studies would be useful to confirm this view.

What other sources of information might be available? [Buckner 1996] identifies computer user groups as useful sources of information, however, the home user is unlikely to join a user group in advance of purchasing either a PC or information products. We suggest that the home user is most likely to look to review articles to inform their judgement.

Relevance of Reviews

Reviews of information products are readily available to the majority of users who might consider purchasing information products for use in the home environment. Reviews appear in quality Sunday and daily papers; popular computing weekly and monthly magazines; lifestyle and other popular magazines; and, specialist magazines for librarians and educationalists. Most of these sources are available across the counter in newsagents, with a few being more normally obtained by subscription. Additionally reviews are appearing increasingly in electronic form on the World Wide Web (WWW).

Whilst reviews are available for the general public or home user, the literature on the content of and criteria to be used in reviews has tended to focus on reviews aimed at library and information science professionals, e.g. [Bosch & Hancock-Beaulieu 1995], [Zink 1991], [Harry & Oppenheim 1993a], and [Harry & Oppenheim 1993b]. However, [Clark 1993] agrees with [Gillham & Buckner 1996] that the characteristics of the home user of CD-ROM products, and arguably of their requirements from product reviews, are essentially different from those of the professional.

The reviews themselves tend to be limited in length to a few short paragraphs providing a brief overview of the information content, multimedia features and searching capabilities of the products. A certain style of review seems to have arisen (in the sources which *home users* are likely to read), reflecting the style of the products themselves, in which small easily digestible chunks of information are presented to the reader [Roberts 1996]. Does this matter? Do the reviews actually provide users with sufficient information to enable them to make informed decisions about which product to purchase? Do the reviews provide sufficient information on those criteria which the users identify as being important [Gillham & Buckner 1996]? Do the reviews provide sufficient information on those criteria which appeared to be important through observation of usage in practice? These are some of the questions which we attempted to address.

Aims of this Study

Consideration of the above has led us to determine three main areas as the focus of this study:

- to determine the nature of reviews and the criteria used by reviewers in assessing the products, including a comparison of information provided in different categories of print and electronic media.
- to compare the criteria from reviews with those which are important to home users including those which are identified by the user and those identified through observation.
- to devise a transferable methodology which can be used for evaluating information provision for other users of information CD-ROMs e.g. libraries, schools.

Methodology and Approach

Our first priority was to identify those sources of reviews which might be read by UK home users of CD-ROM products. Subsequently we were able to identify categories and sub-categories of media types. Two broad categories can be identified as print and electronic media. Some overlap may exist as some print media now also publish electronic forms of their publications e.g. national newspapers. Our categorisation is shown in [Tab 1].

The purpose of this categorisation was to enable us to a) ensure that we gathered appropriate data [Robson 1995], and, b) determine whether or not reviews offered in the different categories and sub-categories provided a different type of review to the reader and whether one type of review was more effective in terms of providing relevant information to the user. The electronic media category was mostly comprised of WWW sources but also included some newspaper sources from CD-ROM. We did not attempt to locate reviews posted in electronic news groups or other discussion lists.

Category and sub categories	Reason for selection
Print media	
Sunday and daily newspapers	Readily accessible by the widest audience.
Weekly and monthly computing magazines	Aimed at those actively seeking information about computers.
Lifestyle and other popular (non-computing magazines)	Aimed at those who have a lifestyle which may indicate they may have an interest in interactive multimedia products.
Specialist magazines (not normally aimed at home users)	Reviews aimed primarily at the information specialist but may also be seeking products for their own use.
Advertisements by CD-ROM publishers	Aimed at those seeking specific information about a particular product.
Electronic media	
Sunday and daily newspapers	Aimed at a wide spectrum of readers but not yet as widely read as print newspapers.
Reviews by public bodies	Reviews aimed at the specialist but accessible by all.
Ad hoc reviews	Reviews aimed at the general population but sometimes with a particular bias towards one group of readers.
Reviews by publishers	Reviews aimed at those seeking specific information about a particular product.

Table 1: Categories and Sources of Reviews

To limit variation in the data the sample selected was restricted to reviews of multimedia encyclopaedias and reference works. Sample size was limited to some extent by the resources and time available for the study; 31 reviews were included in total. Reviews were selected from the most recent issues and sources available. In all categories a range of publications and a range of products was used.

Once the sample selection had been completed the data was scanned using appropriate OCR software to digitise the data. Careful validation of the digitised data was important to ensure accuracy. A coding scheme was devised which would enable relevant components of the review to be coded against particular criteria. The review data was coded (using NUD.IST qualitative data analysis software [Q.S.R. NUD.IST 1997]) by the two researchers thus ensuring consistency of coding. Where ambiguity was a possibility definitions of coding criteria were developed.

For the entire document, reviews were coded according to media type (electronic or print); critical tone; product placing; main emphasis of the review; and whether the review had been written for a specific target audience. The text components (the minimum text component was one line) in each review were coded as either descriptive or evaluative. Components which were deemed to be evaluative were also coded according to whether the reviewer had adopted a positive, negative or neutral attitude. Sections of the documents comparing the product with other media types (CD-ROMs, Internet or print sources) were coded. At the detailed level we coded according to the categories discussed in previous studies by [Gillham et al.1995] and [Gillham & Buckner 1996]: textual information; multimedia; access; interactivity; aesthetics; interface; and system performance. Additional coding categories enabled us to look at other aspects such as quantity of information, authority with which it is written, depth of information, national focus and perceived purpose of the product.

Analysis and Discussion

Introduction

Analysis was carried out on the reviews which had been coded as described above. Three sets of figure are available for each of the codings made. These are:

- the percentage of documents that contain *some* text coded for a particular factor.
- the percentage of the text *about the factor* in those documents that *have some text* coded in the area of interest.
- the percentage of text *about the factor* in *all* the documents.

Nature of Reviews

A notable difference was found between the reviews appearing to be aimed at a general audience compared to those targeted at a more specialised reader. In the former category are reviews in newspapers, lifestyle and computing magazines and on non-specialist WWW sites. These reviews tended to be general in nature and at the detailed level were mostly concerned with the quantity and quality of the product often in comparison with competing CD-ROMs or previous versions. The latter included specifically educationally relevant WWW sites such as 'Superkids Educational Software Review' [Superkids 1996] and magazines such as CD-ROM Librarian. Reviews in this category were not generally any longer than the non-specialist ones but were more focused in their evaluation and less generally descriptive.

Of the reviews in the study 81% are essentially evaluative; only 19% (6/31 reviews) are purely descriptive and this includes the four electronic reviews from the publisher's WWW sites and one print based advertisement placed in a specialist computing journal. Whilst almost all documents (90%) have some purely descriptive parts most of the text (58%) in the reviews is taken up with analysis and evaluation. This often includes descriptions but at the same time is essentially evaluative e.g. about the timeliness of information; about the quantity of material in the product; about the effectiveness of search techniques.

Half of the reviews (52%) are about an upgrade to an existing or previously published product; 29% report on new products. Thus most of the reviews (81%) are topical which is to be expected given that the sources in which reviews appear are mostly what could be termed news oriented publications. It is noted that most reviews of upgrades seem to assume that the reader is familiar with the previous version.

Retrievals in 7 out of 31 documents (23%) stressed newness as the main feature of the review. Of these 7, 4 were from electronic newspapers (4/5 of the electronic newspapers) which stressed the timeliness of the information due to Internet links, for example:

"...there are Web links to even more in-depth (and timely) information: every month you get to download a Yearbook collection of some 50 news articles and features from the Encarta Web site. Figure about 600K per month ..." [CNET 1996]

However, as most of the electronic newspapers take their articles from articles which were initially written for the print medium we cannot necessarily assume that they are writing specifically for an audience which they know to be on-line.

Information was the key point of 23% of the reviews, whilst only one review was rated as having multimedia as the most important factor. Over half of the reviews (55%), had no specific emphasis and instead reported on a wide range of aspects. Less than one third (29%) of the reviews were considered to be targeted at a specific market. Most of these were from ad hoc WWW sites (3 of the 5 in this category) or from the specialist print journals (2 of the 3 in this category).

Stated Purpose of the Product

In 68% of the reviews a specific use for the product was mentioned. Research (including 'reference' use) is mentioned in 32% of all documents and 3.3% of the text units of these documents were about research, e.g.:

"All the essentials are of course here, tucked in alongside new features such as quotations, essays and bibliographies - extremely useful for research purposes." [PC Answers 1996]

Homework is mentioned in 16% of all documents and 2.4% of the text units of these documents were about homework. Fun is also mentioned in 16% of all documents and 2.7% of the text units of these documents were about fun. Education is discussed in about a third of reviews (35%), and 6.2% of the text units retrieved in these documents were about education. Commentary when the stated purpose related to educational aspects tended to be at a greater depth than commentary relating to other stated purposes, for example:

"The other part of the content aspect, the level of the material, was what I felt was a tad on the high side. I consider that the majority of the audience for this type of reference material is going to come from kids in elementary and middle schools, and the material seemed to be on more of an upperclass college level." [The Monitor 1995]

This excerpt is just a small part from a much lengthier section on the appropriateness of the level of the material to the perceived market.

Comparison with Criteria which are of Significance to Home Users

In our previous study [Gillham & Buckner 1996] home users ranked evaluation criteria in order of importance. The evaluation criteria used and the mean ranking figures are listed in [Tab. 2] along with some data on them from the reviews.

Evaluation Criteria	% of documents with this feature	% of text retrieved from all documents	Ranking by home users*
Searching	52.0	6.0	2.21
Textual content	65.0	5.5	3.23
Browsing	16.0	1.0	4.27
Multimedia	94.0	9.4	4.31
Aesthetics	42.0	1.5	4.31
Interactivity	35.0	4.9	4.85
System performance	26.0	4.2	4.92

(* mean ranking score from [Gillham & Buckner 1996])

Table 2: Comparison of Features Discussed in Reviews and by Home Users

In the 1996 study, home users ranked searching and text as the most significant features of an interactive product, however, when they were observed using the product they appeared to prefer looking at multimedia features such as video, pictures, animations and audio clips. As can be seen in [Tab. 2] the reviewers also rate multimedia features most highly in terms of the number of documents with some mention of multimedia (94%) and in terms of the amount of space allocated to them (9.4% of all text components). The highest ranked features (searching and textual content) from the previous study feature fairly highly in importance in the reviews. Both features are commented on by over 50% of the reviews (only multimedia is more prevalent) and they also make up a higher proportion of the text of reviews than the other features with the exception of multimedia. Browsing does not score highly in the reviews; this may be due to difficulties in its definition in coding, with review text on searching and browsing difficult to separate. Aesthetics is an area of interest; commented on in 42% of the review but only very briefly (1.5% of the text).

Towards a Transferable Methodology

The methodology which we have devised for evaluating multimedia information products has worked well for obtaining a general view of characteristics of reviews across a broad range of sources. Considerable differences in focus and depth were found between many of the reviews in the general sources compared with the more specialist ones. For example, it is noted above that commentaries on educational uses in specialist reviews were considerably more comprehensive than commentaries on application areas in the more general sources. It would be wise to separate these reviews in further analysis. Some further work is required to refine the criteria for classification of text elements; difficulties were encountered in maintaining consistency of coding because of the different styles and terminology of the reviews. To ensure validity during coding the definitions need to be tightened further.

Some further analysis of the current sample can be undertaken to investigate the value of multimedia information products to schools and for educational purposes but with a very small sample in these specialist categories the results would be somewhat suspect. While most of the results presented here have concentrated on the quantitative features of the coding system, the analysis software used allows the retention of the full text of the

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reviews during analysis. This retains the richness of the data allowing more subtle inferences to be drawn from the texts than is possible with reference to the coding statistics alone. This helps greatly in our reflection on the coding used and its improvement.

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Interactive Multimedia Software for a Course in Introductory Circuits

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Abstract The last decade has seen significant changes in education delivery technology. Computer use is now well integrated into electrical engineering education and courses in "Computer-aided........" are rare. The characteristics of the student population have also changed greatly during this time period. Students are generally more computer literate and much more accustomed to point-and-click interaction, on-line help documentation, and reading lengthy text files from a monitor than their predecessors were. Publishing companies are finding that fewer university students are purchasing required texts and much discussion on how effectively to integrate technology into the classroom is taking place. This paper discusses interactive multimedia software that is being developed for the introductory course sequence in electrical circuits. The philosophy behind the development is presented as well as a sampling an explanation of some of the modules.

Introduction

A continual challenge in teaching is meeting the students' academic needs and ensuring that they are active participants in their own education. Several studies have been made to determine students' learning styles [Montgomery 1995], [Felder and Silverman 1988] and indicate that students best learn actively and are more responsive to visual learning than to aural learning (lectures). Students are more attentive to visual lessons, seem to retain more of what they see over what they hear, and are more comfortable with visual learning. While texts are certainly visual, they tend to be static while computer software and computer networks have introduced students to dynamic visual material that may be modified by the user. As an example, many of the offerings in the venerable Schaum's Outline Series has an interactive version [Edminister 1995].

Interactive multimedia software can play a key and unique role in the educational process. It may be used as a stand-alone educational module that is intended to enable an interested individual to learn about a particular topic or subject [Sears and Watkins 1996]. It may be used as a supplement to classroom presentations [Doering 1996] and engineering laboratories [Mosterman et al 1996], or it may be used as a dynamic textbook [Harger 1996].

The interactive multimedia software described herein is under development and is a series of interactive modules that will reside on CD-ROMS. These modules could be used with appropriate textbooks on introductory circuits as a stand-alone study vehicle or as a strong asynchronous learning supplement to an on-campus course.

Overview

Many electrical engineering textbooks published today come with software that is bundled with the text. This software contains application or data files that may be used in conjunction with a course (for example, [Etter 1993], [Math Works 1992]). The software provided is usually an analysis package that may be used when performing tedious calculations, graphing results, and solving elementary design problems. Some included software contains examples that a student may view or even change the values of the parameters to see how these variations affect the solution. For example, the Schaum's interactive outline on electric circuits [Edminister 1995] comes with Mathcad embedded within it so that the student may modify illustrative problems and use the Mathcad scratchpad to perform calculations.

The software being developed and presented here is different from these types of packages. It deals with concepts, applications, and visual tours that go well beyond the standard analysis package often accompanying textbooks. This interactive multimedia is a series of modules that together form an electric circuits tutor. Each module is associated with a basic topic in introductory circuit analysis. There are three basic module types: the *study* module, the *applications* module, and the *examination* module.

The *study* module consists of an interactive exposition of the material necessary to understand the topic being studied. For example, the module on circuits, charge, and current flow shows the student what a circuit is , what charge is , and how the movement of charge is current, and finally the concept of current direction and reference current. Some very basic concepts such as the passive current convention, current division, voltage division, and the notion of elements in series or parallel are especially difficult for some beginning students to grasp. Animations should make these and other concepts much easier to understand. Basically, the study module is an interactive lecture somewhat similar to a classroom experience in which there is information exchanged in both directions between a student and an instructor.

A second kind of module is the *applications* module. This module consists of demonstrations, design examples, and tours of various aspects of electrical engineering. Movies, audio clips, and animations will be generously used in these modules. Examples of the kind of exercises that could be seen in these modules are simulations of very basic laboratory experiments, movies on power production that show briefly the working of an electric power plant, and rather rigorous problem solving sessions. The purpose of the applications module is to show the student the practical use of the topic studied and an interactive experience based upon the knowledge acquired in the study module.

The third module is the *examination* module. This module tests the student on the material covered by the two other modules and grades the test automatically. Questions are randomly generated so that no two students' examination would be the same. It is not intended that this modular examination replace either traditional in-class or take home examinations. The instructor's role in testing is an important one because he/she can evaluate what a student does and does not understand. Moreover the instructor can ascertain why students do not understand certain topics from carefully crafted examinations. Instructor grading provides invaluable feedback and allows the instructor to stress certain topics, change presentation methods, and, if necessary, redo certain parts of a course. However, the examination module provides the student with fast, reliable feedback *before* the traditional examination and may catch learning deficiencies before they become ingrained. Moreover, the examination module may be used to grade the work and present an accurate evaluation of a self-study student.

Today there are many software tools for producing interactive multimedia applications. These tools are used to create an environment that simplifies the authoring process and act as an assembly point where photos, movies, animations, audio clips and original material may be more easily integrated. The modules described here have been developed using Macromedia's Authorware [Macromedia 1995] as the authoring tool. Authorware was chosen for four reasons: 1) It has a relatively short learning curve for its basic use. 2) The programming consists of placing icons on a flowline which acts as a script and determines the sequence in which Authorware executes them. The resulting flow diagram is easy to read and different individuals can work on the same piece or integrate pieces without much difficulty. 3) Authorware is a cross platform tool and can run on both PC's and Apple computers. 4) The modules can be packaged as executables so that a user need not have Authorware to run the modules.

The Modules

The electric circuit tutor interactive multimedia software under development will contain a series of study, applications and examination modules.

The Study Module

The study modules cover specific topics that are contained in nearly every elementary circuits textbook. Examples include: Circuits, charge and current flow; Electric potential and voltage; Resistivity, resistance, and Ohm's Law. The study modules cover the material by emphasizing student interaction and decision making. If a student has read the textbook, the study module is designed to provide an interesting and thought provoking way both to review the material and to get another perspective on the material other than that of the author of the textbook. This module is designed to supplement a textbook--not replace it. If the student has not read the textbook, he or she will be able to learn from the study module , but it will become clear that the text is a necessary partner in the learning process.

A flowline for a typical study module is shown in Figure 1. The introduction announces (video and audio) the title of the module and gives any special instructions. The objectives map (expanded and shown as the "objectives" window in Figure 1) presents the student with the objectives of this module. When there are multiple objectives (the usual case) the objectives are presented one after another on the same screen. The rest of the flowline varies with each module. The "Ques. 1 Curr Dir" window in Figure 1 shows the flowline of a simple animation. First, positive charges are moved across the screen from left to right (see Figure 2), then, the student is asked to show the direction of current flow. The exercise is repeated for negative charges. The frame entitled "Hot Words" shown near the bottom of window "mod1s.a3w" shown in Figure 1 is where the results of clicking hypertext (hot words) are stored.

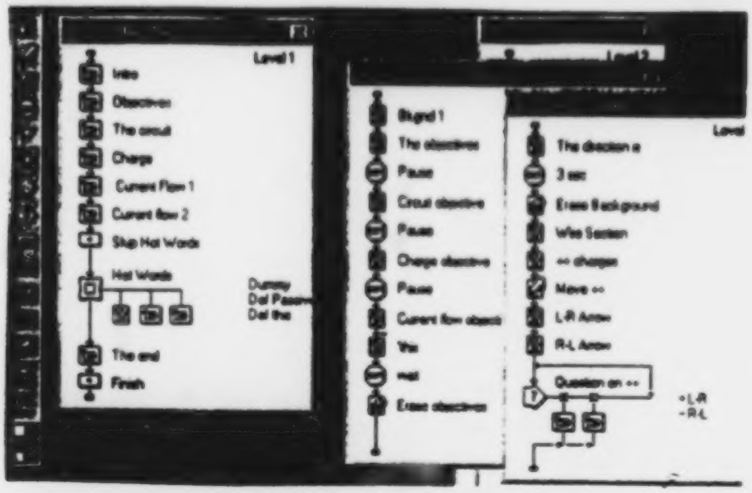
Level 1
Intro
Objectives
The circuit
Charge
Current Flow 1
Current flow 2
Skip Hot Words
Hot Words
Dummy
Del Pass
Del the
The end
Finish
Level 2
Bkgrd 1
The objectives
Pause
Circuit objective
Pause
Charge objective
Pause
Current flow objecti
Wa
wait
Erase objectives
Level
The direction a
3 sec
Erase Background
Wire Section
++ charges
Move ++
L-R Arrow
R-L Arrow
Question on ++
+L-R
-R-L

Figure 1. Flowline of a Typical Study Module

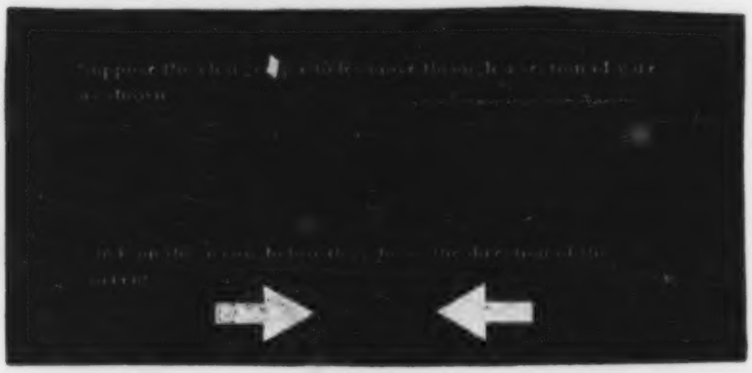

Figure 2 Sample Animation on Current Flow

Within the study module there are many explanations, animations and other ways students may interact with the material. Figure 3 shows a screen that demonstrates the passive current convention. The format of the screen is typical of many of the modules. On the left side of the screen shown in Figure 3 is an explanation of what is happening or what will happen. The right side of the screen is the animation or demonstration. The arrow moves from top to bottom. As the arrow representing current moves "through" the element, a positive and negative sign, each highlighted by a circle, are placed at terminals A and B, respectively. The thin arrows and the text from which they

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emanate are then added. Finally the explanation at the bottom of the right hand side of the screen is added. When finished, the student clicks the continue button and proceeds onward.

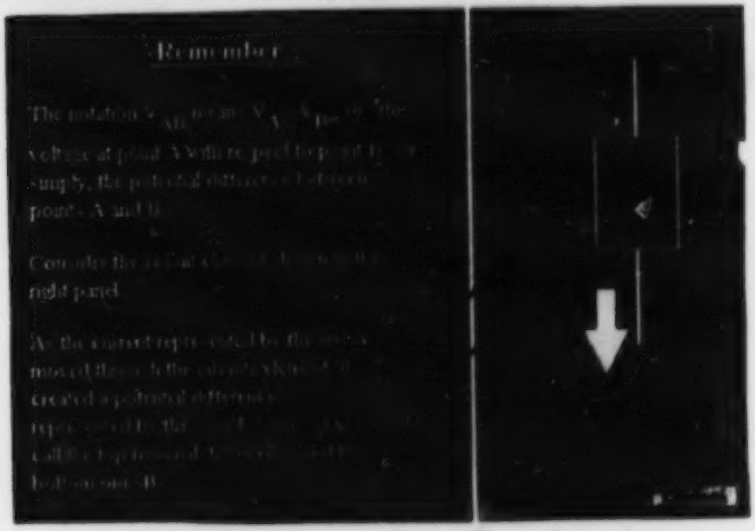

Figure 3 Demonstration of Passive Current Convention

Another way of interacting is through multiple choice buttons. In Figure 4 is a question about potential energy posed to the student after a discussion about it. The student presses the button representing an answer and then is told if the answer is correct or incorrect. If incorrect, an explanation as to why is given. Other interaction techniques include building the circuit that satisfies certain specified criteria using a point and drag technique, selecting objects that represent correct elements, circuits, measurements, etc., and questions with time limits. The philosophy of the study module is that the set up material, the lecture if you will, must be very brief. Demonstrations and animations are very important and show the student how to perform a certain task or explain how something works. Audio is used sparingly in the study modules. Students are directed to their instructor if it is detected that they are having problems with a specific concept.

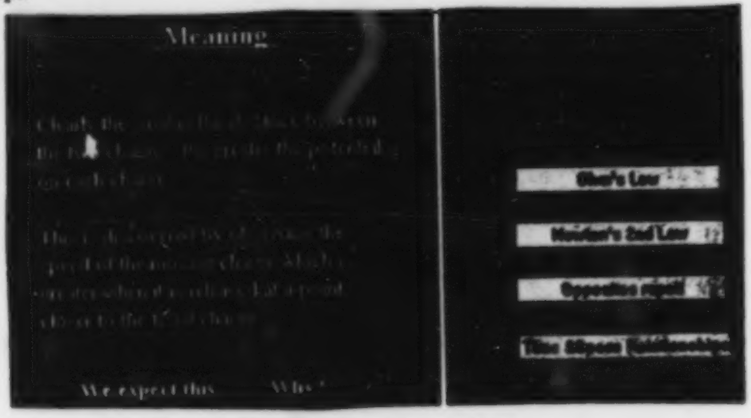

Figure 4 A Question on Potential Energy

The Examination Module

One of the strongpoints of the Authorware authoring software is its ability to judge, track, and record a student's performance. Judging means determining whether the student's response is correct or incorrect. Tracking means collecting and storing data about how a student reacted during the examination. For example, how many times

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the student tried to get the right answer and how long was spent on each problem. Recording means saving all or selected portions of the information that Authorware obtains in a file so that it may be used later [Macromedia 1995].

Each examination covers the material contained in one or more study modules. The examination modules are rather formal examinations similar to in-class tests. The student would use a calculator or could use problem solving software such as MATLAB through a window accessible from Authorware. The other software may be made accessible to the Authorware user through Microsoft's dynamic data exchange protocol as long as the software resides on the same system as the Authorware executable. Although the examination module is the formal testing module the study modules are also testing modules in that they require constant interaction and decision making by students.

The flowline of a typical examination module is shown in Figure 5. As shown the module begins with an introduction that identifies the module and provides detailed instructions on how to proceed. The student enters his or her name and a password. This enables the student's responses and other relevant information to be recorded in a file. It also enables the student to quit the exam at any time and to resume where he or she stopped. The additional data generated by the student will be added to the student's examination file. The test consists of questions grouped by subject area (e.g. current and voltage dividers) for easier report filing but they need not be. For example, Group 1 consists of six questions on resistivity, power and energy. The student is given three questions generated randomly from this group to answer. Consequently as the question base is made larger the number of possible different tests increases dramatically. Most of the questions require the student to respond with a numerical solution of with an equation from which the student may be calculated. The report mentioned in the flowline of Figure 5 is actually several reports to the student. Figure 6 shows the performance report for a student after being tested on Group 3 which covered resistors in series. Since a student is able to submit, then change, a response to a question there may be more responses than questions asked. The student is told how many answers are correct and incorrect and how much time was spent on the group. The instructor gets much more detailed information as shown in Figure 7. Besides the information that the student gets the instructor gets a listing of every answer and response the student makes on the test. This will help the instructor locate areas of misunderstanding for each student.

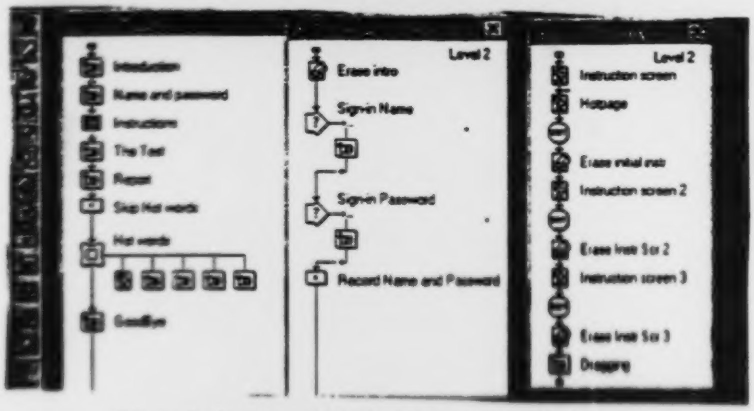

Figure 5 Flowline of Typical Examination Module

Performance Report

Figure 6 Student Performance Report

```
Brian          password
 ******* The answers for group 1
Q4     16.8
Q3     10.6
Q5     -6.2
 ******* The answers for group 2
Q15    12
Q11    4.8
Q10    1
Q7    2
Q13    16
 ******* The answers for group 3
Q20    44 ohms
Q22    67
Q18    30
Q21    90
 ******* The answers for group 4
Q25    10 ohm resistor
Q26    25 ohm branch
Q24    8 ohm resistor
```

Figure 7 Report to Instructor

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The examination modules are really self-examination modules in that they are written to help students gauge their progress and help the instructor pinpoint areas of difficulty. They are not designed to replace an instructor's normal testing protocol.

The Applications Module

Applications modules allow descriptive material, experiments, and expository material not easily available to students to be brought into the course. These modules contain simulated basic experiments such as measuring voltage and current, constructing circuits to demonstrate current and voltage division, etc. Also there will be video clips that allow students to "visit" industrial locations and will give the students a better feel for the relevance of the material within the engineering profession. Finally, some of the applications modules deal with the pioneers of electrical engineering and their work and will allow students to get a better feel for the historical development of electrical engineering.

Final Comments

Interactive multimedia holds promise for enhancing collaborative learning. As authoring tools become more sophisticated interactive multimedia could play a key role in the total educational experience. Especially intriguing is the artificial intelligence aspects as the authoring tool environment that may eventually allow instructors determine what faulty logic process or incorrect understanding of theories prevent students from learning correct techniques and methodologies.

At present there is a downside to developing interactive multimedia modules. There is a learning curve for the authoring software. Moreover the authoring software is but one in a series of packages that are used. Various packages are needed for recording and editing audio clips, scanning and editing photographs, developing and editing movies, creating animations, and burning CD ROMS. The usefulness of the software is impacted by the financial stability and the support commitment of the vendor offering the software. Changes in operating systems and radical upgrades can cause difficulties in maintaining an efficient development environment. Very important is the amount of time it takes to put together modules (one rule of thumb is that it takes 100 minutes of effort for every minute of completed work). Mastery of the subject material is but one aspect of the total effort. Mastery of all the software plus an ability to marry the subject matter and its presentation in a captivating and innovative way is no small task. Even with these difficulties, interactive multimedia offers a new and exciting environment for learning.

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Using Dynamic Hypertext to Create Multi-Purpose Textooks

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Abstract: In textbooks the different topics are introduced in an order which is (supposedly) the best way for learning the subject at hand. Once the student masters the subject, most textbooks are not well suited for use as reference material, because related topics are not located near each other. This paper presents a framework for self-modifying hyperdocuments. A textbook, delivered as on-line hypertext, transforms itself into a reference book during the learning process. This is accomplished by modifying the link structure and the node contents each time a hypertext link is followed. This framework is illustrated by means of the courseware for an on-line course on "Hypermedia structures and systems", developed at the Eindhoven University of Technology, and currently offered at six different universities in the Netherlands and Belgium, by means of World Wide Web technology.

1. Introduction

Hypertext is being used more and more often in distance education, as a replacement for paper course texts. A textbook usually suggests only one (linear) reading order. The student can of course elect to read the pages in a different order, but it will always be obvious to her that she is deviating from the intended reading order, and in many cases such alternative order does not make sense. A hypertext offers many (supposedly) intended different reading orders. Every page (or node) contains links to a number of different pages which can be read next. Despite this flexibility, the link structure in a (hyper)textbook cannot offer complete navigational freedom because concepts must be introduced or defined before being used, and storylines must be preserved. This implies that detailed or advanced pages must only be accessible after reading introductory pages. Such a link structure makes a hypertext version of a textbook unsuitable as a reference book, because the advanced information, which is used most in such a book, is not directly accessible from the starting page(s) of the course text.

The most important factor rendering course texts unusable as reference material is the inability to change the terminology or wording depending on the student's progress through the course, or to change the link structure during the learning process, to enable links to advanced pages from the starting page when the student is ready to read and understand them. As an example, in a course text on the subject of hypertext, the word *page* can be used to indicate what is normally called a *node* (in hypertext terminology), until the student has read an explanation of the concept of *nodes*. Almost everywhere the word *node* is needed in the course text the word *page* can be substituted automatically, until the definition of *node* is read. Such minor variations in textual content are unobtrusive. The student will probably still recognize the text when visiting it again, so she will not be tempted to read it all again as if the node were completely new. Larger variations in a text can of course also be introduced, but may confuse the reader because a page she thought she read before would suddenly look completely different.

Variations in the link structure are not only needed for modifying the access path to advanced reading material. In a textbook it is common to first define a concept or term, and then move on to the applications of that concept.

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In reference books, the opposite order is sometimes also used: throughout the text some concepts or terms are used, which the user may or may not know; links (or references) to the definition of these concepts or terms provide access to these definitions, so the reader who isn't aware of an exact definition can easily get to it. Such cross-references are also used in textbooks, but in most cases for backward references (pointing to information to review if needed), and seldom for forward references (pointing to previously unread information). Hence, the modifications to the link structure that are needed to transform a textbook into a reference book are more intricate than simple "unveiling" of links when the reader is ready to follow them.

This paper describes research and experimentation with dynamic hypertext structure and content, in order to guide the student through the learning process, thereby slowly transforming the course text from a textbook into a reference book. Prototype software has been written to enable teachers to create and deliver such dynamic course texts through World Wide Web. A successful course on "Hypermedia structures and systems", organized by the Eindhoven University of Technology, and offered (through the Web) to students at six different universities in The Netherlands and Belgium, is now being used as a test case for evaluating the use of this dynamic hypertext courseware. This course was chosen because hypertext is not only the medium through which the course is taught, but is also the subject matter of the course.

This paper is organized as follows: Section 2 gives a brief review of previous research on adaptive hypermedia. Section 3 describes the possibilities and dangers of using dynamic link structures, and shows how they are used in the hypermedia course. Section 4 shows how the addition of dynamic node contents can improve usability of hypertext courseware even more, but also how it can confuse readers if used carelessly.

2. Quick Review of Adaptive Hypermedia Research

Since the early seventies computer-assisted instruction (or computer-aided instruction, or CAI for short) researchers have been trying to develop adaptive systems by mimicking human-to-human interaction [Wenger 1987] [Self 1988]. However, the first attempts at putting documentation on-line closely followed the existing book model. Hypertext links were only being used for linking from a table of content or an index to the appropriate pages, and for explicit ("see also") cross references. This did not remove the essentially linear style of the presentation, thereby making it difficult to convey non-linearly structured information.

A primary concern when using hypertext for the creation of a course text is the structure to be given to the knowledge it conveys so that students can easily and naturally find the most appropriate information depending on their needs [Bareiss et al. 1993]. To make information presentation in a hypermedia environment effective and its management efficient, it is necessary that text, graphics, and images are properly coordinated [Hekmatpour 1995]. Some researchers, e.g. [Feiner et al. 1991], [Maybury 1991] have investigated the automatic generation of coordinated multimedia; [Carver et al. 1996] for instance have proposed (and implemented) a system for generating personalized hypermedia course presentations depending on the student's learning style, rather than based on the student's (fore)knowledge. From the learning style they generate a selection of prefered media types, but then go on to generate a linear presentation of multimedia information objects. [Merlet 1993] has focused on how to control and manage the diverse elements that concur in the composition of a multimedia document. What has emerged from all these (and other) studies, and what they all share, is the fact that they have shown and proved the inefficiency of the classical book model for on-line systems. This does not yet address the specific requirements and limitations of the on-line presentation of information through hypermedia systems.

Reading paper documents demands that the reader adapts to the level at which information is presented. Often too few details are provided to avoid the need to consult other sources of information. (A bibliography at the end of the book refers the reader to more information.) But also, often too many details, background or other information are given which the reader wishes to skip. When a book is presented on-line it becomes much more difficult to skip unwanted parts than with a paper document. Turning pages and very quickly skimming the text is something most, if not all, people can still do more easily with a (paper) book than with an on-line document. (We can, for instance, often find a certain illustration in a 200 page book in under 2 seconds by flipping the pages very rapidly, but we cannot yet do this with an on-line system.) In a hypermedia system it is possible to adapt to the reader by applying technology from intelligent tutoring systems or artificial intelligence, but even the simple technique of putting introductory information or summaries in separate nodes that provide links to nodes with detailed information can significantly improve the usability of a hyperdocument for a varied audience.

Most previous studies on adaptive systems have only focused on dynamically assembling information and presenting it according to the user's class and/or knowledge state without including the user's learning procedure in identifying which information to present to students. [Carver et al. 1996] are an exception to this, since they do apply learning styles to select media types, but then use them to generate a linear multimedia presentation, not really a hypermedia presentation. In the framework we propose we adapt the selection of links and the content of nodes without switching between media types. In fact, in the hypermedia course at the Eindhoven University of Technology almost all information is offered as text only. Furthermore, we propose not to assemble information nodes, but to limit textual modifications to otherwise static nodes. Slight modifications are enough to avoid the use of technical terms or concepts for which the user has not yet read the definition.

3. Using Dynamic Link Structures

The organization given to on-line documentation mostly depends on the kind of information that has to be delivered. However, whatever the structure may be, the underlying purpose in outlining the subject matter is to make it as simple and as useful as possible [Rojas-Fernandez 1991]. An unstructured information space topology can indeed give rise to problems similar to the GoTo statements in computer programming [Tomek et al. 1993]: difficulties on the side of the user in understanding the application domain and a consequent navigation breakdown due to uncontrolled linking.

Graph-theoretical methods have been used [Botafogo et al. 1992], [Begoray 1990], [DeYoung 1990] for analyzing link structures. These methods identify link structures that are unusable no matter what the content of the nodes is and regardless of the visual aids that may be provided to help the user in understanding this structure. To quote DeYoung [DeYoung 1990]:

> "(...) if a hypertext is a densely connected unstructured graph, no presentation of the mess is going to clean it up or make it conceptually easier to understand."

However, while these methods are able to find link structures which are likely to be unusable, they cannot guarantee that link structures having all suggested values for different metrics will actually belong to highly usable hyperdocuments. Empirical findings have demonstrated that links are often introduced without a deep consideration of their actual use and usefulness [Campagnoni et al. 1989]. Because of the lack of a clear methodology for linking as well as of a common understanding of what the notion of link eventually means, users often happen to be unable to understand why some piece of information is at the end of a certain link and they may also fail to understand why they are sometimes unable to find what they are looking for [Landow 1987]. So, linking one piece of information to another can not only fail to provide the expected benefits, but, in some cases, it even frustrates users. Since the mere presence of links in a hyperdocument seems to suggest that the relationship between the interconnected materials is a significant one, it becomes very difficult for users to ignore them.

Instead of searching for the "ideal" link structure for a hyperdocument, we opt for a system that adapts the link structure during the browsing process. A static link structure, possibly displayed graphically to provide a better overview, uses a "spatial metaphor" for guiding the user. Our approach, with links that are created and removed at different points during the browsing process, uses in some way a "temporal metaphor" [Calvi 1996]. However, because as soon as temporal relationships are mentioned in a hypermedia context this concept is often interpreted as involving real-time aspects, we will not use the term "temporal" to describe our approach, but rather use the terms "dynamic" or "adaptive".

A common problem with static hypertext is the abundance of links, many of which may not be appropriate at all times. As part of the course 2L690, "Hypermedia structures and systems", at the Eindhoven University of Technology, students have to convert a (linear) review of hypermedia research (by V. Balasubramanian from Rutgers University) into a hyperdocument by splitting the document into reasonably sized nodes and by adding links. Some pages offer an explanation of concepts that are used throughout the text. A typical example is the page describing what *nodes and links* are. Both the course text and the hypertext review used for the assignment contain a page describing what *nodes and links* are. In the (dynamic) course text the student is carefully guided to the definition page early in the reading process. In the hypertext review used for the assignment this is difficult to achieve because the table of contents invites the reader to go off in any desired direction. Almost all students create a large number of links from pages throughout the review to the *nodes and links* page (and to some other descriptive pages). The navigational possibilities of each student's version of the hypertext review are so overwhelming that it is difficult to predict where the reader will meet the concept of *nodes and links* first. Consequently the students create links to the *nodes and links* page from every possible source. Because in this assignment work the students can only create a static link structure, their only solution would be to select interesting places for linking to the *nodes and links* page very carefully. The students have neither the time nor the skill to perform this task.

The software for the hypermedia course keeps track of all nodes read by each individual student. With each node three "knowledge identifications" can be associated:

- **Required knowledge** is knowledge that is needed in order to view this node. The system will automatically hide (conditional) links to nodes for which the user has not yet acquired this knowledge.
- **Forbidden knowledge** is knowledge that makes viewing this node uninteresting. The system will automatically hide (conditional) links to nodes for which the user has acquired this knowledge.
- **Generated knowledge** is knowledge the user gains after reading this node. (By "after" we mean that a node which generates its own forbidden knowledge can be viewed once, because the forbidden knowledge is only gained after visiting the node.)

Whether certain links appear or not depends on the combined knowledge id's a student has acquired. But regardless of the student's knowledge, there are also **unconditional links** which are always shown.

Using knowledge id's we can make links accessible when the reader is ready for them, and make them inaccessible again after the reader has no need for them anymore. The link structure of the course text changes each time the student follows a link. This technique is used in the courseware for the hypermedia course in the following way:

1. When the student first visits the course, the starting page gives some kind of table of contents, but provides no other links than one to a node containing instructions about the use of this courseware.
2. When the student returns from the instructions page, the first three "chapters" of the course text become accessible. These chapters are an introduction, a set of definitions, and a historic overview of hypermedia research and development. The student may follow different paths through these chapters, and depending on the path taken, the link structure within these chapters may also differ.
3. After reading some of the nodes of these chapters, and completing a small (multiple-choice) test at the end of each chapter, links to the more advance chapters appear in the table of contents.
4. While reading, some links will disappear. Links to definitions of terms will disappear after reading these definitions. Links to nodes containing unimportant background information will also disappear after looking at that information (in the hypermedia course there are nodes that briefly describe the IBM PC, the Macintosh, etc. which we do not expect the student to wish to read multiple times).
5. After reading (some of each of) the advanced chapters, a link to the final assignment appears in the table of contents.

Figure 1 gives an impression of what the table of contents page looks like, when only the first three chapters are available.

Hypermedia structures and systems

Welcome to course 2L690 at the Eindhoven University of Technology.
If you are just beginning to browse through this course, you should first read the instructions. . .
This course contains the following (not necessarily disjoint) parts:

- Introduction (it is advised to read this before the other items)
- Definition of hypertext and hypermedia
- The history of hypertext and hypermedia
- The architecture of hypertext systems
- Navigation (and browsing semantics) in hypertext
- . . .

Figure 1: Possible table of contents of the hypermedia course.

From the example of the hypermedia courseware it is clear that a dynamic link structure can be used to eliminate confusion that could be caused by providing links to information the student is not yet ready for, or that the student has already read and may not wish to find other links to. However, seeing a different selection of outgoing links each time a node is visited can also be confusing. Therefore, the pages with a varying link structure must be limited and well chosen. The table of contents is an excellent candidate for a node with a varying link structure. Through the links in this node large parts of the course text can be enabled at once. In the hypermedia course, most other use of dynamic link structure is in the elimination of links to definition nodes and to unimportant background information.

From figure 1 we may observe that apart from the presence of links, the presentation of the path leading to different chapters is identical. No reason for the absence of links to the advanced chapters is given. Similarly, pointers to the definition of *nodes and links* are given in the introduction, while the use of these terms could be easily circumvented, thereby eliminating the need for guiding the reader to that definition. A solution for these problems is presented in the next section on dynamic content.

4. Dynamic Content, or How to say something in Other Words

A student at the Eindhoven University of Technology developed a first hypertext courseware on environmental law back in 1990. In order to circumvent the need for learning lots of definitions and terms right at the start of the course two versions of each node were produced: one using common English vocabulary and one using the proper technical terms. Depending on the knowledge of the student (which was measured in a way somewhat similar to our current approach), the introductory or the advanced version of a node was presented. As a result of offering different versions of the content of a node the link structure could also vary, because some links that were present in one version of a node might not be present in the other version.

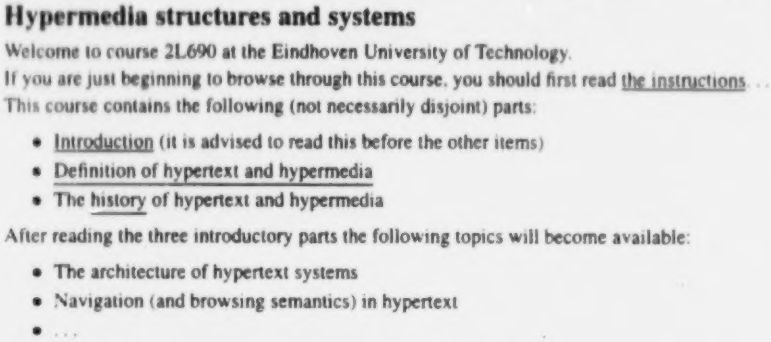
Having two (or more) completely different versions of a node can be confusing:

- After reading the introductory version of a node a student may continue browsing, thereby gaining the necessary knowledge, and then revisit the node without knowing so and reading the advanced version without realizing it is actually the same as the introductory version, up to some rewording.
- Because students may not revisit a node after reading the introductory version, the author must make sure that that introductory version contains the same information as the advanced version. Authors may be tempted to leave out important parts because they are difficult to describe without using technical terms.
- Different parts of a node may depend on different definitions or terms. One would like to have more than two versions of the entire node. Maybe two versions of every paragraph or sentence would satisfy this need. However, nodes which contain some paragraphs using concise technical vocabulary, and other paragraphs with plain English vocabulary may be very awkward to read.

In the software for the hypermedia course, the Unix C preprocessor is used to select between arbitrary pieces of text (using #if constructs). Although this offers the possibility for large modifications, we use dynamic content only for small variations in content:

- In the table of content (and other places), additional text is added to explain why certain chapters are still unavailable.
- In the text, some technical terms, like *node* and *link* are carefully replaced by the non-technical terms *page* and *reference* or *cross-reference*.

Figure 2 shows the table of contents for the hypermedia course, after applying dynamic content modification.



Hypermedia structures and systems

Welcome to course 2L690 at the Eindhoven University of Technology.

If you are just beginning to browse through this course, you should first read the instructions. . .

This course contains the following (not necessarily disjoint) parts:

- Introduction (it is advised to read this before the other items)
- Definition of hypertext and hypermedia
- The history of hypertext and hypermedia

After reading the three introductory parts the following topics will become available:

- The architecture of hypertext systems
- Navigation (and browsing semantics) in hypertext
- . . .

Figure 2: Table of contents with dynamic content modification.

5. Conclusions

Using hypertext for course texts is non-trivial because the navigational freedom, typically associated with hypertext, may conflict with the need to study concepts and definitions before moving on to applications or advanced topics. Dynamic link structures and content can be used to guide the student throughout the learning process, while preserving as much nagivational freedom as desired. Hypertext textbooks can be transformed into reference books by gradually changing the structure during the browsing process.

However, the use of a technical framework for supporting dynamic link structures and dynamic content does not guarantee a usable result. Dynamic link structures must be used with care because unexpected changes in the link structure may confuse the student, and excessive content changes may cause students to read the same (but rephrased) information several times, not realizing that, or wondering whether two such versions represent the same information or not.

In the course "Hypermedia structures and systems", taught (only) through World Wide Web at the Eindhoven University of Technology (and taken by students at six universities) we are using dynamic link structures and dynamic content sparingly, in order to benefit from this framework, without causing more confusion with the students. All browsing actions of all students are currently being logged for later evaluation and for comparison with previous logs of students who have used a version that had no dynamic link structure and no dynamic content.

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BROCA: A Computerized Environment for Mediating Scientific Reasoning through Writing

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Abstract: This paper describes a computerized learning environment for teaching the conceptual patterns of scientific reasoning. BROCA (Basic Research, Observations, Critical Analysis) is theory-driven, combining two very powerful conceptual models of thinking. The first – drawn from cognitive psychology and information theory – focuses on the mental manipulations by which data becomes information and information becomes knowledge. The second theoretical construct comes from rhetoric and describes the intellectual activities carried out in prewriting, drafting, and revision by an expert writing. As an interactive "cognitive tool," BROCA provides scaffolding (through visual algorithms and adaptive prompting) to help a fledgling thinker practice the robust patterns of scientific reasoning.

1 Introduction

The written word is crucial to science for at least two compelling reasons. First, the texts of science -- publications that report findings -- are the life blood of progress for a community of researchers. Framing a question of interest, designing an experiment, collecting data and observations, analyzing the raw findings, and interpreting results in light of theory -- all these demanding tasks are the *process* of science, but the written word provides the vehicle for dissemination of the *product*.

Second, writing is important to science because the act of placing ideas into language mediates higher-order intellectual activities that are foundational to scientific thinking [Kuhn, Amsel, & O'Loughlin, 1988]. Though other symbol systems play a major role in scientific reasoning, language fosters mental manipulations such as synthesis, analysis, classification, inferencing, definition, hierarchical order, comparison/contrast, elaboration/extension. Some of the most respected of twentieth-century educational theorists have endorsed this notion of writing as a vehicle for learning and for understanding. Vygotsky [Vygotsky, 1962], Luria [Luria & Yudovich, 1971], and Bruner [Bruner, 1971], to name only a few, have pointed out that higher cognitive functions seem to develop most fully only with the support of verbal language -- particularly, of written language.

In broad terms, the process of scientific inquiry mirrors the writing process. Both the scientist and the writer go through an initial gathering and sorting out of ideas, from which tenuous though testable explanatory notions are made (hypotheses for the scientist and thesis statements for the writer). After considerable trials, sound relationships between entities are found (experimentation for the scientist and drafting for the writer) and a supportable belief structure emerges. Continued scrutiny (replication in science and revision in writing) results in knowledge -- an artifact that can take its place in the body of received opinion. Because of this similarity of intellectual activities, writing can be used as an analog for scientific thinking.

This paper describes a multimedia, interactive learning environment that weds forms of scientific inquiry to forms of scientific discourse. BROCA (Basic Research, Observation, and Critical Analysis) is an end-to-end knowledge development environment that mediates the intellectual activities implicit in scientific thinking. Our claims are that BROCA – when integrated into an appropriate curriculum – will:

- Increase competence, creativity, and confidence in formal reasoning.
- Promote and sustain interest in scientific investigation.
- Engage the user and transfer powerful strategies for problem-solving.
- Bridge the gap between process (thinking) and product (writing).
- Improve quality of writing by improving quality of thinking.

BROCA aids learners in two specific categories of intellectual activities. First, the software aids the user in harvesting existing information artifacts (e.g., websites, electronic databases, professional literature, as well as hands-on experimentation). Second, BROCA guides the student in the processing and interpreting of these sources to find patterns of meaning that answer a specific research question. BROCA does not contain any "canned lesson." Its content consists of a set of "inquiry tools" and a supplemental curriculum that provides five "authentic" content domains from which the learner formulates a problem and conducts an investigation.

2 Curriculum and Instructional Design

BROCA is the foundation for a multi-disciplinary course, "Writing as Reasoning in Science and Engineering." However, the software is not intended to be "stand-alone." It is a teaching resource to be used in conjunction with a problem-oriented course that presents writing (and other variations on "image-making" and visualization) as a vehicle for scientific inquiry and critical thinking. Additionally, when delivered as an "empty engine," the BROCA software can also be adapted to other, more technical courses, provided the instructor shares the basic premise that writing is central to the deep-learning of scientific concepts and content.

2.1 Course Content

For "Writing as Reasoning in Science and Engineering," five content domains were selected in order to make use of the unparalleled scientific resources garnered by U. S. government agencies. Current U.S. policy has mandated that all Federal agencies make their wealth of materials, facilities, and expertise available to educators and students. The course sequentially presents students (working in teams of three or four) with opportunities to conduct investigative studies within five "authentic" domains.

- *Non-terrestrial Ecosystems:* Research into Advanced Life Support for Lunar and Mars habitation is being carried out at several NASA Centers (e.g., Ames, Kennedy, and Johnson).

- *Astronomy and Instrumentation::* Drawing from NASA's archives of data and images, this unit asks the learner to work with research problems dealing with stars and stellar evolution.

- *Applications of Remote Sensing Data:* This suite of problems is taken from scientific resources on near-earth imaging, drawing from NASA, DOE, and the National Center for Global Environmental Change (NIGEC) databases.

- *Designing and Engineering for Zero-Gravity:* This module presents materials from NASA's extensive experience in "mechanics" as applied to a zero-gravity environment.

- *Science and Public Policy:* The last module focuses on science policy and decision analysis by examining rich case studies dealing with funding.

The "questions" students formulate and then investigate are on the order of a "thought experiment." In other words, they are scientific in nature, but they are open-ended and their solution(s) can be derived (or more appropriately "imagined," then reified through research, development, and verification) through methods of thinking more speculative and imaginative than classical scientific investigation might foster.

2.2 Instructional Design and Cognitive Theory

A thought experiment is intended to liberate the scientific mind from the rigors of formalism and to allow for a new way of thinking about bold (wild versus tame), ill-defined problems. We have designed the BROCA exercises to use both qualitative and quantitative methods, to engender both analytical and holistic thinking, and to incorporate creativity, imagination, synthesis, informed guessing, and even serendipity into the more routine definition of the problem-solving process.

The actual BROCA software contains mediated workspaces and suites of inquiry tools (cognition enhancers) to teach the strategies of investigating, thinking, and writing. However, the resource materials for all the content units are distributed across a range of information forms (artifacts) and sources. [Fig. 1] depicts the distributed nature of resources and the centralized tools for inquiry in the BROCA "learning environment." As currently designed, students construct their own research agenda, but are pointed to several rich sources for initial investigation.

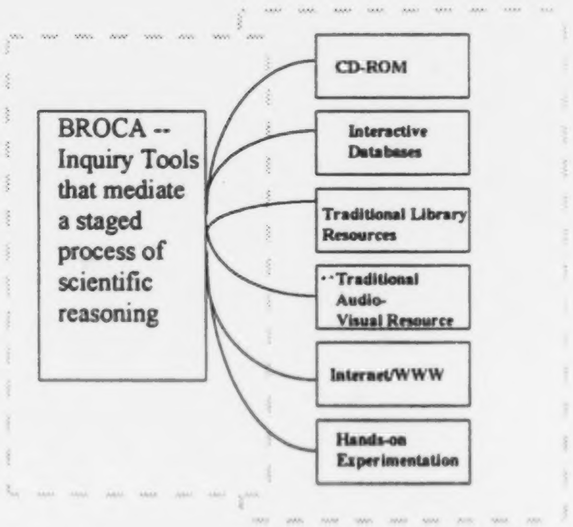
BROCA -- Inquiry Tools that mediate a staged process of scientific reasoning
CD-ROM
Interactive Databases
Traditional Library Resources
Traditional Audio-Visual Resource
Internet/WWW
Hands-on Experimentation

Figure 1: BROCA's Centralized Inquiry Tools Act as an Interface for Decentralized Information Resources

Each "thought experiment" draws from a combination of disciplines: geology, biology, chemistry, physics, meteorology, and ecology, as well as economics, politics, and social and ethical considerations. However, the problem does not depend upon a thorough understanding of the "theories" or "method" or body of "facts" of any one discipline. Rather, BROCA works at a higher level to help the learner generalize both cognitive and meta-cognitive strategies for rational problem-solving. Using the online inquiry tools built into BROCA, the learner will be able to:

- develop strategies for information gathering,
- recognize patterns and relationships,
- evaluate strengths and weaknesses of data,
- predict outcomes using extrapolation or interpolation,
- and design and conduct focused investigations after the formulation of problem statements.

3 Developing Software to Mediate Scientific Reasoning

We base the design of BROCA on two explanatory models: one from information science and one from cognitive science's finding on discourse strategies. We do not intend our resultant hybrid model to be reductive or prescriptive. Rather, we see this "cognitive tool" [Salomon, 1993], [Salomon, 1988], [Salomon, Perkins, & Globerson, 1991] as an enabling prosthetic to help scientists-in-training recognize and take control of demanding intellectual processes.

Our first model comes from the general premise that there is a qualitative difference between *data*, *information*, and *knowledge*. Data are discrete entities, such as facts. While a body of *data* assembled for a specific purpose undoubtedly has relationships among the elements, these patterns of meaning must be extracted through an examination of the set and a filtering out of extraneous pieces. The systematic processing of data produces *information*, or statements about the associations in the data. Information is a codification and a clarification of the connections in data that produces more compact and easily remembered interpretative statements. A synthesis of information builds belief structures more comprehensive and more resilient than those contained in information.

Thus, *knowledge* is more powerful than information in that it has predictive or explanatory value. In other words, knowledge structures become both the product and the continuing impetus for such intellectual activities as exercising judgment and making rational decisions. These differences -- and more importantly, the transformations that take place when moving up the ladder of abstraction -- are the foundations of human memory and thinking. Moreover, this hierarchical model of knowledge evolution is central to many of the emerging applied fields coming out of the cognitive sciences.

Our second model comes from the cognitive science research into the importance of strategy acquisition for thinking and writing. Generalized models of good thinking include an array of techniques (strategies) for accomplishing goals, knowledge about when and how these techniques should be used (metacognition), and an extensive, task-specific knowledge base that is used in conjunction with the strategic and metacognitive processes [McCormick, Miller, & Pressley, 1989]. Realization that good thinkers have a repertoire of problem-solving behaviors for various types of tasks launched a new pedagogy for strategy acquisition.

[Fig. 2] illustrates how we have conjoined the two models and used the process of scientific reasoning merged with the strategies of discourse to create a cognitive architecture by which BROCA melds scientific reasoning with the rhetoric of science. Basically, we specify the problem spaces (data, information, knowledge) as arenas for exercising scientific thinking and the state transitions as discourse manipulations necessary to create a tangible, codified "belief structure" which will be passed up the ladder of abstraction as a value-added artifact to be operated upon in the next higher-level workspace.

We have modeled the process as three problem-spaces (data, information, knowledge) and three state transitions (prewriting, writing, revision). Manipulations within each of the problem-spaces requires its own specific set of heuristics. For example, within the data workspace, the thinker is basically examining evidence against a set of goals or expectations. This guided exploration involves a set of procedures or rules-of-thumb by which the thinker sorts out the noise from the data. Methods guiding the exploration are an established set of principles that the thinker has learned, either formally or informally.

3.1 Teaching Scientific Thinking Skills Using Computer Mediated Writing

BROCA performs the role of a mentor by mediating the process of scientific reasoning from beginning (data collection) to end (written report containing "new" knowledge). Using visualizations of what might otherwise be opaque mental operations, the software guides the user through (1) collection/evaluation of evidence, (2) comparing data with theory, (3) formulating and testing hypotheses, (4) interpretation of results, (5) validation through replication. These complex mental activities take place within the framework of a second multi-dimensional, staged cognitive task -- that is, producing an acceptable piece of scientific prose (journal article, lab report, scientific journalism). Embedded within this authentic task are the profound acts of understanding necessary to transform observations into prose, or to move from data to knowledge.

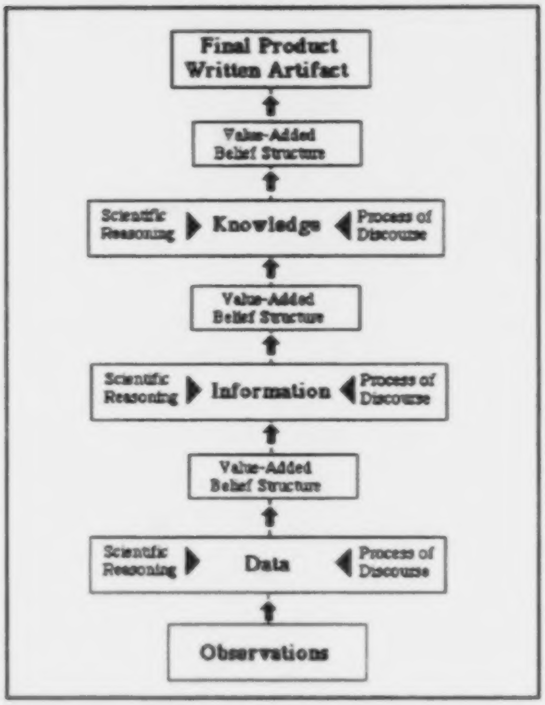
Final Product
Written Artifact
Value-Added
Belief Structure
Scientific Reasoning
Knowledge
Process of Discourse
Value-Added
Belief Structure
Scientific Reasoning
Information
Process of Discourse
Value-Added
Belief Structure
Scientific Reasoning
Data
Process of Discourse
Observations

Figure 2: Theoretical Foundations of BROCA

Returning to [Fig. 2], we can map the learning activities supported in BROCA onto this cognitive framework. Each of the five content modules in BROCA follows a basic pattern of guided-inductive reasoning, building an enriched "belief structure" in three central stages:

- *Stage One: Observations and Judicious Collection of Data:* The learner explores a set of basic elements in a domain and formulates a question of interest. Early cognitive activities include using language – as written artifact and as structured oral discussion to (1) capture a "rich" representation of the problem's dimensions, (2) discover what the learners know about the problem, (3) isolate gaps in understanding and anticipate where the learners are weak in background, and (4) develop a plan for continued focused inquiry. Also, the students will learn how to keep an observation journal and to record both affective impressions and objective observations (and to distinguish between the two). These "written artifacts" are essential in finding a solution and must be at least partially completed before moving to the next level.

- *Stage Two: Establishing Relationships and Testing Them against Principles:* Having completed the task of establishing a research agenda (investigation plan) and having constructed information artifacts pertinent to the investigation, the learner is guided through the process of creating information from data. (Since the model is recursive, the learner – in creating this next-level artifact – may notice gaps (missing or incorrect data) and will need to return to the collection/observation phase to remedy this. Generalized activities include observing features, identifying potential patterns, accounting for anomalies, and providing tentative explanations (hypotheses). These "reasoning activities" are mediated by a set of writing and visualization-based heuristics for enabling thinking. For example, the learner is taught how to use "concept mapping" to try out various orderings and relationships in the body of initial observations.

- *Stage Three: Establishing Superordinate Concepts and Presenting Solution(s):* Knowledge is more powerful than information in that it has predictive or explanatory value and can be integrated into a known body of "givens." In the third stage of each BROCA module, students must prove their hypothesis and

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construct an acceptable knowledge artifact. In short, after exploring the subject domain (data) and working out a richly interconnected "belief structure" drawn from these explorations (information), the learners must shift their attention to constructing a textual artifact that meets a set of external constraints and social expectations. Visual algorithms (thinking frames) and adaptive prompting help students to (1) prune away extraneous or erroneous elements from the problem-space, (2) accomplish critical "state transformations" for information structures – such as clustering specifics and making superordinate categories, and (3) link new knowledge with prior knowledge.

4 Summary and Conclusions

This paper describes the conceptual design of BROCA, a computerized environment to merge the "language" of science with the manipulations, observations, and calculations fundamental to scientific reasoning. Inherent in the discussion are three overarching assumptions about the design and development of advanced educational technologies. First, the design of automated systems should be rooted in cognitive science and educational theory. Advanced instructional technology holds great promise; however, to truly move beyond pale imitations of existing educational media, designers must harvest the rich insights on how humans think and learn already established by cognitive psychology. Second, complex, multi-staged problem solving (in this case, scientific thinking) is an amalgam of visual and verbal symbol usage. By concurrently performing the manipulative/observational tasks along with the consolidative/interpretive tasks, the learner integrates both lower and higher level intellectual processes, as well as concrete and abstract forms of mentation. Third, highly sophisticated, interactive learning environments are possible without using the typical intelligent tutoring system (ITS) approach of constructing a student model, a domain knowledgebase, and an interpretive expert system. By employing cognitive task analysis, the system designer can model the process of the domain and embed adaptive help within the user's performance of the task. Such "cognitive tools" are just emerging as serious competitors to the more traditional approaches to adaptive pedagogy in interactive systems

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Hypermedia Environment using a Case-Based Approach to Foster the Acquisition of Complex Knowledge

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Abstract - Hypermedia environments have been pointed out as potentially successful sources for learning, particularly to the acquisition of complex knowledge. However some problems have arisen related to orientation: users either felt lost in hyperspace or they couldn't cope with a great amount of information.

We used a case-based approach to foster complex knowledge acquisition and to analyse user orientation or disorientation. Learning is measured in how much knowledge is transfered to new situations. An experimental study has been conducted and is described. Results about knowledge transfer and user orientation are available.

Introduction

Hypermedia environments have been pointed out as potentially successful sources for learning, due to its non linear organisation of information, the use of several communication supports such as text, video, sound, graphics and pictures, and the possibility to choose different paths according to user interests or needs (Conklin, 1987). Studies show that users feel lost in hyperspace and others can't cope with huge amounts of information (Conklin, 1987; Edward and Hardman, 1989; Kim and Hirtle, 1995). Some investigators suggest that learners who are in an introductory phase of any subject do not take advantage in learning from hypermedia environments (Spiro and Jehng, 1990). These environments are more suitable to the acquisition of complex knowledge.

Complex knowledge

When we look at very complicated systems we generally find that the basic components and the basic laws are quite simple; however the complexity arises because many of these simple components are interacting simultaneously and there is a myriad of possible ways in which the components of the system can interact (Waldrop, 1992). Therefore, the whole is more than the sum of its parts.

Advanced knowledge acquisition implies learning complex conceptual material (Spiro et al., 1988). The learner must attain a deep understanding of content material, reason with it, and apply it flexibly in diverse contexts. However some obstacles arise to advanced knowledge acquisition that include conceptual complexity and the increasing ill-structuredness. By ill-structuredness Spiro et al. (1988) mean that many concepts are interacting contextually in a case and their patterns of combination are inconsistent across case application of the same type. This opinion is shared by Waldrop (1992) when he states that in a truly complex system the exact patterns are not repeatable, in spite of the existence of recognizable themes; for instance, in history we can talk about revolutions, even though one revolution might be quite different from the other.

Advanced knowledge learning has significant context dependent variations, and requires the ability to respond flexibly to "messy" application situations, so compartmentalizing knowledge, presenting clear instances and employing reproductive memory criteria are often in conflict with this kind of knowledge (Spiro et al., 1988). Oversimplification of complex and irregular structure, overreliance on a single basis for mental representation, on "top down" processing, context-independent conceptual representation, on precompiled knowledge structures, rigid compartimentalization of knowledge components, and passive transmission of knowledge reduce important aspects of complexity (Spiro et al., 1988; Feltovich et al., 1993). Rand Spiro and his colleagues suggest some solutions to deal with complex knowledge through Cognitive Flexibility Theory. It is important to demonstrate complexities and irregularities and to show how the superficially similar is dissimilar and how superficial unities are broken. Cognitive flexibility involves the selective use of knowledge to adaptively fit the needs of understanding and decision making in a particular situation: knowledge assembly depends on having available, as full as possible, a representation of complexity to draw upon. Multiple representations are important because knowledge that will have to be used in many ways has to be learned, represented and tried out in many ways. Cognitive flexibility depends upon having a diversified repertoire of ways of thinking about a conceptual topic.

Deficiencies in the learning of complex material that are widespread and widely recognized include three major types: misconceptions and incorrect knowledge, the inability to flexibly apply knowledge in new situations, and the lack of retention of knowledge that was acquired at an earlier time (Feltovich et al., 1993). Deep and useful understanding of complex educational subject matter is not commonplace (Feltovich et al., 1993). Educating and testing for understanding of complicated material may require special, directed effort that is so resource consuming that it cannot be applied widely across the many concepts of a given curriculum (Feltovich et al., 1993). New visions of instruction and assessment are required if education is to promote deep understanding of complex, difficult subject matter (Feltovich et al., 1993).

Various forms of failure in advanced knowledge acquisition are frequently associated with traditional learning and instruction. Cognitive Flexibility Theory emphasises the importance of repeated presentations of the same material in rearranged instructional sequences and from different conceptual perspectives (Spiro and Jehng, 1990). This theory claims a case-based approach and generalizes Wittgenstein's metaphor of the criss-crossed landscape. By criss-crossing conceptual landscapes, interconnected knowledge structures are built that permit greater flexibility in the ways that knowledge can potentially be assembled for use in comprehension (Spiro and Jehng, 1990). Flexible learning environments permit the same items of knowledge to be presented and learned in a variety of different ways and for a variety of different purposes (Spiro et al., 1991).

Learning is not a passive process of receiving information; it is rather an active process of constructing new knowledge and incorporating it into what is already known (Feltovich et al., 1993). Knowledge is in many ways bound to the contexts in which it is learned. Conceptual knowledge should be acquired in close coupling with its application and use (Brown et al., 1989).

Case-based approach

A case represents specific knowledge tied to a context and it teaches a useful lesson when it exemplifies a new way of doing something or a new effect that is likely to be useful in later reasoning (Kolodner and Leake, 1996). Cases can came in many different shapes and sizes, covering large or small time slices (Spiro and Jehng, 1990; Kolodner and Leake, 1996).

New solutions are generated not by chaining, but by retrieving the most relevant cases from memory and adapting them to fit the new situations (Leake, 1996). Reuse of prior solutions helps increase problem-solving efficiency by building on prior reasoning rather than repeating prior effort. Cases make it possible to interpret open-ended and ill-defined concepts (Kolodner and Leake, 1996). Reference to previous similar situations is often necessary to deal with the complexities of novel situations; thus, remembering a previous case to use in later problem solving and integrating that case with what is already known is a necessary learning process.

Situations (problems or stories) are interpreted by comparing and contrasting them with previous similar situations and learning happens as part of the process of integrating a new case into memory (Spiro and Jehng, 1990; Kolodner, 1993). Cases need to be decomposed and represented along many partially overlapping dimensions, i.e., the same information must be represented in lots of different ways and many connections must be drawn across the decomposed cases, thus establishing many possible routes for future assembly (Spiro et al., 1987).

We applied cognitive flexibility theory that uses a case-based approach to a hypermedia environment and as complex knowledge we selected a 19th century portuguese novel: *O Primo Basílio*, written by Eça de Queirós.

Description of the hypermedia: "*O Primo Basílio*: múltiplas travessias temáticas"[1]

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[1] "*Cousin Basilio*: multiple thematic criss-crossing".

This hypermedia offers to the user the opportunity to learn about the novel *O Primo Basílio* through different paths, all of them contributing to the construction of new and multifaceted understanding.

On the Main Menu (see figure 1) several options are available: "View Cases", "Special Topics", "Thematic Criss-Crossing", "Table of Contents" and "Quit".

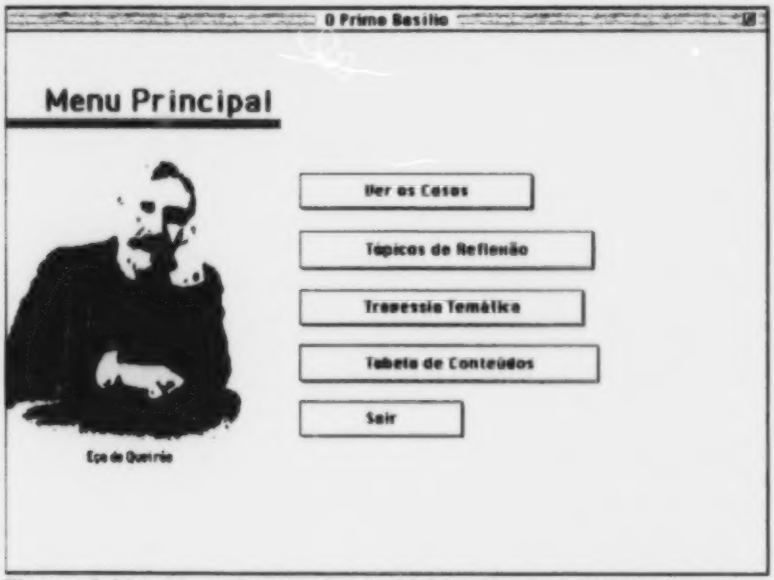

Figure 1. Main Menu of the hypermedia "*O Primo Basílio*: múltiplas travessias temáticas"

This hypermedia presents five cases and nine themes, i.e., nine thematic dimensions of analysis (see figure 3). These cases are sequences of the novel and they are analysed from the perspective of nine different broad scope and partially overlapping thematic dimensions of analysis. A general description of each theme is given when the button (see figure 3) "Descrição dos Temas" is selected.

Each case has small units referred to as mini-cases (see figure 2). Each mini-case presents information about the 19th century to the user (first button: "C" stands for "Context") that may help to recreate that time and helps to understand the text. The fourth button "Thematic Commentaries" provides a list of the relevant themes as its thematic commentaries which describe how the conceptual themes are tailored to the particular mini-case.

The user[2] has access to information about his path on the second button "Navigation Orientation".

The following button (3rd) gives access to a general "Themes Description", and the fifth button allows the user to write his own "Notes".

In "Themes description" and in "Thematic Commentaries" some authors are referred to or quoted, so a button "Referências" with the full references is available. The pictures and movies provided in this hypermedia present information about that time like furniture, vehicles and places, or even songs that are symbolic in the novel.

On each mini-case the user has always information about the name of the case in the bare (see figure 2) and the name and sequence of the mini-case, for example, "1. As leituras". Spiro points out that the user doesn´t get lost in hyperspace because he is never more than one connection away from the focus of instruction (Spiro et Jehng, 1990).

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[2] For the purposes of this communication the user or learner will be referred to as he.

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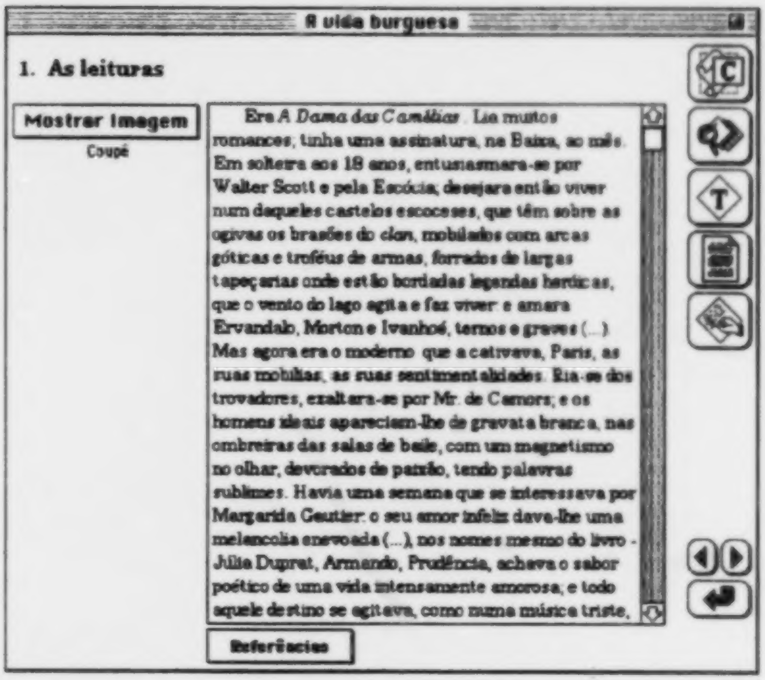

Era *A Dama das Camélias*. Lia muitos romances; tinha uma assinatura, na Baixa, ao mês. Em solteira aos 18 anos, entusiasmara-se por Walter Scott e pela Escócia; desejara então viver num daqueles castelos escoceses, que têm sobre as ogivas os brasões do *clan*, mobilados com arcas góticas e troféus de armas, forrados de largas tapeçarias onde estão bordadas legendas heróicas, que o vento do lago agita e faz viver: e amara Ervandalo, Morton e Ivanhoé, ternos e graves (...) Mas agora era o moderno que a cativava, Paris, as suas mobílias, as suas sentimentalidades. Ria-se dos trovadores, exaltara-se por Mr. de Camors; e os homens ideais apareciam-lhe de gravata branca, nas ombreiras das salas de baile, com um magnetismo no olhar, devorados de paixão, tendo palavras sublimes. Havia uma semana que se interessava por Margarida Gautier: o seu amor infeliz dava-lhe uma melancolia enevoada (...), nos nomes mesmo do livro - Júlia Duprat, Armando, Prudência, achava o sabor poético de uma vida intensamente amorosa; e todo aquele destino se agitava, como numa música triste,

Figure 2. Mini-case "As leituras" from the case "A vida burguesa"

In the path "View Cases", each mini-case is deconstructed through several thematic commentaries that explain how a general theme is applied to the particular text. The reconstruction of knowledge implies its previous deconstruction. Flexibility in applying knowledge depends on cases being disassembled so that they may later be adaptively reassembled (Spiro et al., 1987).

With the path "Special Topics" the investigator suggests five topics. For each topic relevant mini-cases and thematic commentaries were preselected. The user does a specified traversal among cases and themes that are important to understand the suggested topic.

In the path "Thematic Criss-Crossing", in portuguese "Travessia Temática" (see figure 3), the user may select the theme(s) and case(s) he is interested in. It is a free exploration of themes and cases according to the user's interests or needs.

Both paths mentioned previously promote awareness of representation of complexities and multiple connections across cases. The user criss-crosses the "landscape". The difference between both paths is on user control: in "Special topics" a predefined path is offered, while in "Thematic criss-crossing" the user is free to choose its own.

The "Table of Contents" presents all cases, its mini-cases and its applied themes. From this table, the user can have access to any mini-case she wants.

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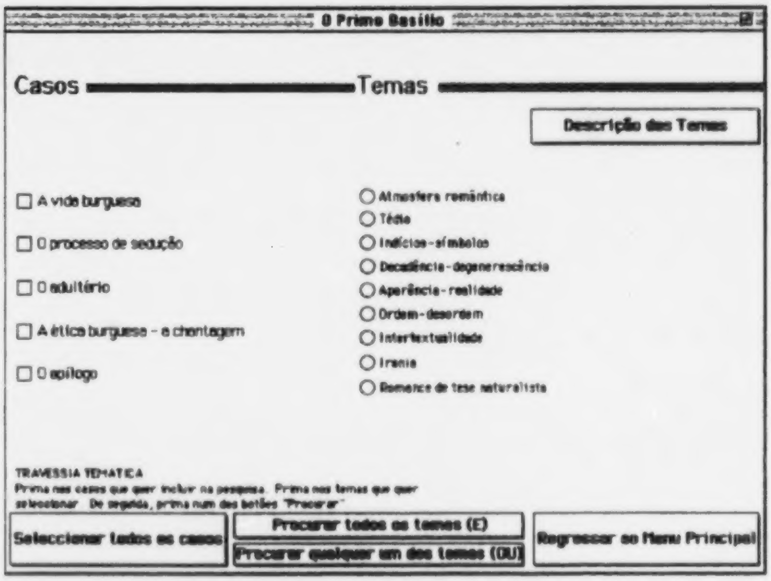
O Primo Basílio
Casos
Temas
Descrição dos Temas
☐ A vida burguesa
☐ O processo de sedução
☐ O adultério
☐ A ética burguesa – a chantagem
☐ O epílogo
○ Atmosfera romântica
○ Tédio
○ Indícios-símbolos
○ Decadência-degenerescência
○ Aparência-realidade
○ Ordem-desordem
○ Intertextualidade
○ Ironia
○ Romance de tese naturalista
Seleccionar todos os casos
Procurar todos os temas (E)
Procurar qualquer um dos temas (OU)
Regressar ao Menu Principal

TRAVESSIA TEMÁTICA
Prima nos casos que quer incluir na pesquisa. Prima nos temas que quer seleccionar. De seguida, prima num dos botões "Procurar"

Figure 3. "Thematic Criss-Crossing"

Problem and Research Questions

Hypermedia environments have seduced educators in order to develop learning applications, however some problems arise with cognitive overload and users' desorientation. Cognitive flexibility theory proposes a theory of learning and knowledge representation to foster the acquisition of complex knowledge.

Several studies pointed out to good results when cognitive flexibility theory is applied (Jacobson, 1991; Jacobson et al.,1995; Torres, 1995; Moreira, 1996). We intend to validate this theory in a portuguese context and we are also interested in verifying Spiro and Jehng's (1990: 201) statement about the user's orientation: he "can never get lost".

We intend to answer these main research questions:

- How important is "thematic criss-crossing" in knowledge transfer?
- How important are "thematic commentaries" in knowledge transfer?
- Does the user get lost in hyperspace?

Method

Three treatments are considered in this study, that imply three slighty different hypermedia.

Hypermedia 1 (CFT)	Hypermedia 2 (NCC)	Hypermedia 3 (NTC)
Themes description	Themes description	Themes description
Thematic commentaries	Thematic commentaries	Applied themes
Oriented Thematic criss-crossing	Thematic criss-crossing designation only	Oriented Thematic C-C. (no thematic commentaries)
Free thematic criss-crossing		Free thematic criss-crossing
Table of Contents	Table of Contents	Table of Contents

Table 1- Comparison of three treatments

The first treatment applies the principles of cognitive flexibility theory and is the hypermedia described previously.

The second hypermedia is similar to the previous one, but it has no facilities to criss-cross the information (**No Criss-Crossing** available).

The third hypermedia doesn't explain how a particular general theme applies to a particular text, i.e., it has no "Thematic commentaries", but only the designation of themes that apply (**No Thematic Commentaries** available).

All groups spent 3 hours per day, twice a week, during two weeks, working with a hypermedia and doing tests (see table 2). All subjects should have read the novel before starting the study.

Session 1	**Session 2**	**Session 3**	**Session 4**
Subject information sheet	Hypermedia		Hypermedia
Pre-test (A)	Test B	Hypermedia	Post-test (C)
Hypermedia document	Questionnaire of opinion		Opinion Questionnaire

Table 2- Sessions structure

Subjects answered the three knowledge tests: pre-test (A) was done before they started working with the hypermedia, test B during the second part of session 2 and Post-test (C) at the end of session 4. Differences between the three groups were measured on how much transfer each group produced.

Subjects orientation or desorientation and opinions about the hypermedia were measured through an "Questionnaire of opinion".

Sample

Subjects were 3rd year university students, of Portuguese language and literature, volunteers (see table 3). Each group was randomly assigned to each treatment.

	Hypermedia 1 CFT n=16	Hypermedia 2 NCC n=14	Hypermedia 3 NTC n=12
Female	14	13	11
Male	2	1	1
Age (average)	22	22	21

Table 3. Sample characterisation: age and gender.

As the number of subjects by group is too small, non-parametrics tests were used and the accepted significant level is α=.05.

Results

All groups learned significantly from pre-test to post-test: group CFT p=.0004; NCC p=.001 and NTC p=.0022, according to the Wilcoxon signed-rank test.

Statistically significant differences were found among the results of the three groups pre-test, using Kruskal-Wallis test, p=.0009 (mean rank - CFT: 27.25; NCC: 11.57; NTC: 25.42). As the group responsible for this statistically significant differences was the NCC, and the subjects of this group didn´t finish reading the novel as recommended, we decided to compare the CFT and the NTC groups. Pre-test results revealed no statistically significant differences between CFT and NTC groups, p=.6091. These groups revealed statiscally significant differences p=.0071 (Mann-Whitney U test) on post-test (C) .

When comparing post-test/pre-test gains (score 0-20) no statistically significant differences were obtained p=.1009, but group CFT appears on the first place with 8 points, group NCC with 7,5 points and group NTC with 6 points.

Test B revealed a statistically significant difference p=.0160. The order of distribution of the three groups in Test B and C is the same (see figure 4), but there are only statistically significant differences with test B among three groups and groups CFT and NTC in test C.

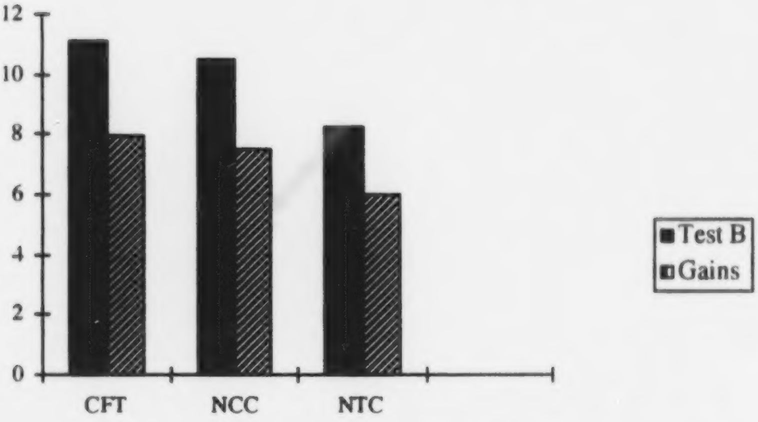

Figure 4. Distribution of Test B and gains.

We may conclude that CFT hypermedia, with all its paths that allow different knowledge representations, is the most effective way of learning. "Thematic commentaries" are responsible for statistically significant differences between groups CFT and NTC. Oriented "thematic criss-crossing" versus "thematic criss-crossing designation only" didn't allow statistically significant differences, and "Thematic commentaries" were responsible for similarities in the results between groups CFT and NCC. In this study we may conclude that "Thematic commentaries" are more important than "thematic criss-crossing" to knowledge transfer to new situations.

At the end of this experiment we offered to groups NCC and NTC the opportunity to see and compare their hypermedia with CFT hypermedia: the two groups had different reactions. Group NTC realized that a lot of information was missing and they would easily answer the tests if they were working with CFT hypermedia. Instead, group NCC prefered their hypermedia because they had to be involved and tried to answer the proposed "thematic criss-crossing designation". Besides, they enjoyed this challenge.

During session 1, according to "Questionnaire of opinion", 50% of subjects felt lost in the hypermedia but on the second session this feeling disappeared, as it could be expected based on Spiro and Jehng's (1990) statement. Subjects enjoyed the study of "*O Primo Basílio*" on the hypermedia and they referred that it would be interesting to have other hypermedia to study other subjects during their courses, because "*in a few hours we learned a lot!* " .

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Supporting the Design of Hypermedia Stories

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Abstract: This paper introduces a conceptual high level design model for HyperStories and HHCASE, a CASE tool that supports and facilitates the building of HyperStories. HyperStories are stories that happen in a virtual and interactive hypermedia environment. The model and tool consider static and dynamic aspects of the hypermedia environment such as the modeling of contexts, interactive entities and navigation. HHCASE also allows to define links between different components of a HyperStory. Finally, relevant issues related to the construction of HyperStories are discussed.

1. Introduction

An emergent line of research and development on hypermedia learning is proposing new ways of producing software to really help learners to learn and think [Ambron 90; Jonassen 90]. Adequate use of hypermedia software may change the way learners normally think by putting flexible tools in their hands to stimulate them to think about relationships. To support this, we have proposed HyperStories [Sánchez 94; Sánchez 95; Sánchez 96; Cernuzzi 94] a new educational paradigm that merges the idea of stories with hypermedia functionality to produce dynamic and flexible software to exercise thinking while acting, playing, exploring, navigating, and having fun. The idea of hypermedia based stories is not new, some ideas were first introduced at the beginning of this decade. However, we consider that more effort should be spent to reach the really educational potential offered by the conjuntion of stories and hypermedia capabilities through a robust model. HyperStories explore new horizons in the use of stories as a mean for helping young learners to construct and reconstruct their thinking structures [Carter 93; Egan 86; Coles 89; Applebee 78; Frisher 88]. HyperStories can be seen as the electronic version of conventional literary stories. By taking the advantages of multimedia technology learners are given a rich environment of contexts, characters, objects and their behavior, links with navigational tools, and friendly interfaces. This involves important tools that can be used to construct and reconstruct learning and cognitive structures. When the learner is engaged with HyperStories, she/he navigates through contexts, manipulates objects, interacts with characters, identifies her/himself with a main character called *protagonist* and moves freely through a familiar virtual world.
Conceptually, we can define a HyperStory as:

HyperStory = Hypermedia + Dynamic Objects + Protagonist

Hypermedia is in charge of representing the environments and the links among them. The dynamic objects are entities with a defined behavior and may react according to the events generated by the learner or other entities. Objects and characters may have their own behavior and act autonomously, eventually influencing the development of the HyperStory. The protagonist is manipulated by the learner and represents the connection between her/him and the system. Furthermore, the learner can also interact with other characters or objects in order to solve a given problem. In doing so, the learner can strongly control the HyperStory. In the below sections, we explore more deeply the constituing elements of HyperStories and introduce a new high level design model and a CASE tool.

2. Designing Hyperstories

Traditional hypermedia design models are inadequate to capture and model several flexible and interactive aspects of HyperStories. In addition, conventional hypermedia authoring tools do not provide an adequate set of facilities for building HyperStories. For this reason, a specially defined conceptual model was presented in [Sánchez 94; Sánchez 95]. The model allows designers to capture and model static environments and dynamic objects by providing a powerful description language that merges ideas from object and context oriented approaches.

However, this model is probably more accessible to designers with programming skills. Hence, in the present work we focus on the high level design process of HyperStories trying to offer more easy-to-use facilities to a wide number of potential authors. Below, we present some HyperStory elements and introduce a conceptual high level design model for HyperStories capturing those elements and their relationships. Then, we present a tool to support the model.

2.1 HyperStory Elements

Many elements compose a typical story, as well as a HyperStory. Here, we want to focus on the script - that may stimulate the learner's motivation and involve her/him in a constructive behavior -, environments - representing the virtual world of the story - and entities.

Script: a Hyperstory, like any other story, has a script. However, while a regular story script is typically fixed and linear, a HyperStory script is dynamic and non-linear. In effect, in HyperStories there exist a surrounded basic script that can be strongly influenced and enriched by autonomous behavior of some entities. Specially, decisions of the protagonist manipulated by the learner may change the progress of the HyperStory. In some way, we can state that the protagonist "is" the story.

This property is presented every time the HyperStory offers the learner the opportunity to choose between alternative paths. These paths may be static (previously defined by the designer) or dynamic (generated by entitiy interactions) and may be explicit or not, thus allowing alternative stories.

Environments: an environment represents the context in which actions occur, and the group of the environments represent the virtual world of the HyperStory. So, the entities, specially the protagonist, may move freely through them complaying with particular restrictions. Normally, these environments are inactive and static, although entities participating may change in time and modify their appearance (e. g. a light can be on or off).

Entities: are objects (animated or inanimated) present in the environments. A special entity is the protagonist, manipulated by the learner. Entities may be active, may move themselves, may have autonomous behavior, act concurrently, interact between them, and alter the environments. In a typical HyperStory, entities are characters and all those objects that are critical to the story. Entity actions are responsible for the HyperStory progress and the course of the progress. In effect, entities influence the protagonist in choosing the path through multiple directions offered.

2.2 HyperStory High Level Design Model

Once the main elements of a HyperStory are described, we introduce a high level design model capturing these elements and their possible relationships.

HyperStory Script (HS): is the composition of a basic plot, with eventually concurrent and partially independent scripts (representing different actions assigned to the characters) and possible protagonist (user) interaction specified in an informal textual language.

HyperStory Flow Diagram (HFD): is in charge of capturing the HyperStory script. Basically consists of a set of shapes connected by edges. Every shape represents a portion of the HyperStory script, a stage in the HyperStory [Fig. 1]. The edges represent the *next* relationship between different portions of the script. The next relationship has N:M cardinality. It is possible to activate different stages of the HyperStory from a particular one (represented by multiple output edges from that shape). A stage could be activated by different ones (represented by multiple input edges to that shape). Shapes and their semantics are similar to that used in data flow diagrams of conventional structured analysis and design. The separation criteria for the stages of the HyperStory is made by the designer and may help to gain a better understanding of the HS.

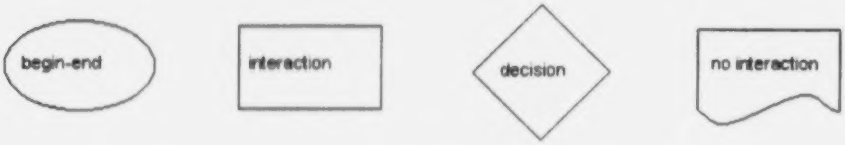


Figure 1: Shapes availables to define HFD

HyperStory Contexts Diagram (HCD): represents all the environments in which the HyperStory occurs and the different relationships among them. Environments are defined through descriptions given by the author and based on a contextual approach. There may exist different relationships between environments. The three we consider more interesting are: ***neighborhood*** (N:M, many environments could be neighbor to many others), ***inclusion*** (1:N, one environment could include many others) and ***perspective*** (1:N, one environment could have different perspectives). Different environments are neighbors if it is possible to have movement between them (e.g. the kitchen is neighbor to the garden and it is accessible crossing a door). Neighborhood is not permanent and not necessarily implies physical adjacency. For example, in a specific moment of the HyperStory it may be impossible to access the garden from the kitchen because the door is locked.
The inclusion relationship allows the designer to represent the inclusion of one environment into another (e.g. a room is included in the house).
Finally, the perspective relationship, similar to the idea presented in [Garzotto 93], allows the designer to represent the same environment from different views (e.g. the dinner room viewed from the kitchen or from the hall, or the dinner room with the light on or off). Environments are modeled by circles and each edge model a relationship. The type of relationship is represented using different colors or line styles for the edges. Furthermore, it is possible to associate a label to the edges in order to specify the navigational semantics, the events that activate the link (e.g. for a neighborhood relationship, the edge may be labeled with the connecting object, such as a door), and eventually constraints to traverse it.

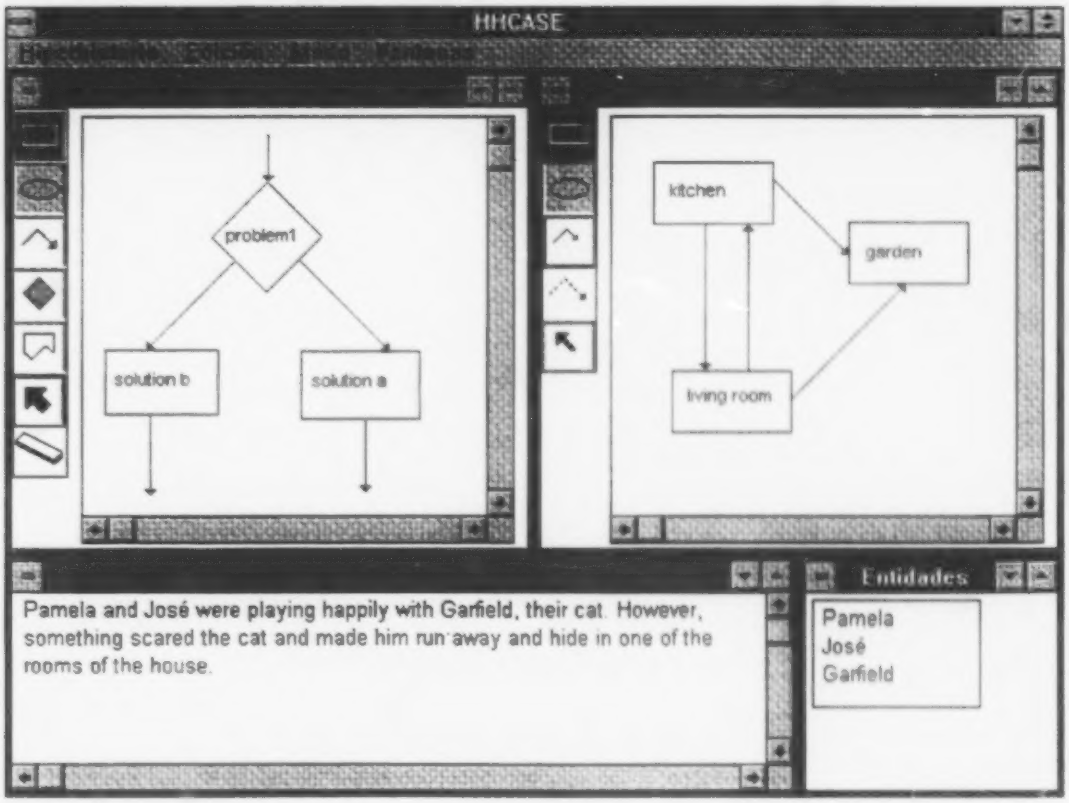
HyperStory Entities (HE): model all defined characters and objects. Similar to the HS, entity behavior and properties can be specified in an informal textual language. They strongly contribute to the resulting HyperStory script.

Many other relationships may be given between specified elements. One of the most useful relationships from a navigational perspective is ***environments-navigability***, which does not directly match with ***the neighborhood-inclusion*** relationships previously defined. It depends on the portion of the HS active in a particular instant (e.g. the kitchen door may be open or closed in different times) and on some entities (e.g. the cat can access the garden through the window but the mother cannot). The set of links modeling all environments-navigability relationships capture hypermedia characteristics and allows the end user to explore different contexts of the HyperStory. The exploration metaphor is very powerful and stimulating for educational purposes. It introduces a difference respect to conventional hypermedia systems, for which navigation is oriented towards search information, that is, a contents-oriented browsing. On the another hand, by exploring the environments, learners may acquire useful information to solve a particular problem or, simply, to recognize the virtual world. In this way, navigational semantics assume a very important role for learner motivation and it is desirable to allow the designer to simplify the specification
Another interesting relationship is ***entities-participation***. It relates the HS to HE and allows designers to specify which entities participate in every stage of the HyperStory. Hence, every entity (active or not), participating (directly or not) in a stage of the HyperStory, collaborates to the story progress.
Furthermore, it is important to specify what contexts are involved in a particular stage of the HyperStory. We call this relationship ***environments-participation***.

One of the mayor problem in designing HyperStories is that they are intrinsically dynamic. Therefore, environment-navigability, entities-participation and environments-participation could result in flexible relationships that may vary depending on time, entities' behavior and learner's interaction. This represent a good example of "dynamic link" problem, pointed out in [Kendall 96; Hardman 93], and we leave deeper consideration on the topic for future works.

3. HHCASE: a New Design Tool

HHCASE is a tool that allows the HyperStory designer to model and possibly reuse HyperStory scripts, entities, environments, and all the previously defined relationships among them. Conceptually, HHCASE is composed of several windows containing diagrams and text, and a set of facilities to create and maintain different kinds of relationships represented by links.
HHCASE is strongly based on the model previously defined and presents a main window and a set of windows which correspond to the four elements described above: HFD, HCD, HE, HS[1]. In particular, HFD and HCD, have associated toolbars that help their edition [Fig. 2].



Pamela and José were playing happily with Garfield, their cat. However, something scared the cat and made him run away and hide in one of the rooms of the house.

Pamela
José
Garfield

Figure 2: Main window and windows defining elements in HHCASE

Furthermore, HHCASE provides a unique and easy way to instantiate different types of relationship. Independently from the relationship type, the process consists of selecting the participant elements for the relationship and adding the relationship to the HyperStory by menu, keyboard or toolbar.

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[1] Names appearing in figures correspond to the spanish version of HHCASE.

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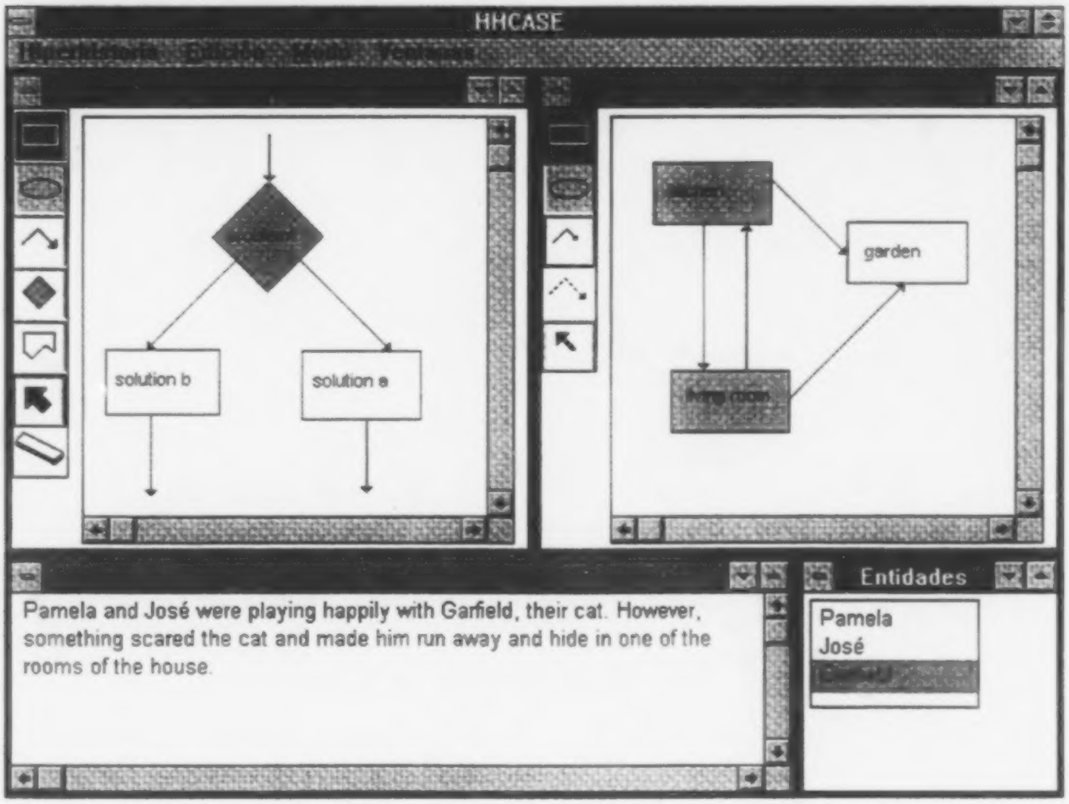
Hereinafter, we present the different types of relationships supported by HHCASE and their semantics:

- *Next*: two elements of HFD representing what is the immediately next stage of the HyperStory
- *Neighborhood, inclusion* and *perspective* among elements of the HCD
- *Environments-participation*: one element of the HFD with a set of elements of the HCD; modeling where contexts are active in a stage of the HyperStory
- *Environments-navigability*: one or more entities of the HS, one element of the HFD and a set of elements of the HCD modeling where entities may navigate through specified contexts in a specific stage of the HyperStory [Fig. 3];
- A relationship between one element of the HFD and a portion of HS modeling where a part is active in a specific stage of the HyperStory.



Pamela and José were playing happily with Garfield, their cat. However, something scared the cat and made him run away and hide in one of the rooms of the house.

Figure 3: Example of *Environment-navigability* relationship

Each relationship can be enriched by textual comments allowing designers to better specify the semantic relationship and eventually Pre-Post conditions. For example it is possible to state that the garden is accessible from the kitchen if the precondition is true: the character has the key.

Finally, we consider that HHCASE provides some interesting qualities:

- modularity and separation of concerns, implemented using different windows and menus;
- enough rigor, provided by well defined elements and relationships;
- flexibility, mainly provided by textual comments;
- ease of use, coping with the special requirement that normal designers may not be programming experts.

However, specification rigor gives designers and developers a unique language with a clear semantic, eventually enriched by comments, facilitating the interface between the design and implementation processes.

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4. Conclusions and further work

In this work we have presented a conceptual model and a CASE tool for designing HyperStories, a modern paradigm to enhance higher order cognitive skills by thinking while playing, exploring, navigating, and having fun. In many aspects, such as interactio, navigation through virtual worlds and challanges, the reader may note a close relationships between this proposed metaphor and MUDs environments. However, MUDs differ from HyperStories because does not have an explicit model and a narrative closure. Moreover, MUDs narrative is less intentional the HyperStory one. HyperStory may be seen as a subclass of MUDs. That implies substantially differences in conceptualization and design approaches. Nevertheless, HHCASE may be used to capture and model some of the critical aspects of MUDs. Designing HyperStories is obviously not trivial and comparatively more complex than designing other hypermedia-based educational software [Cernuzzi 94].
We consider that the present work represents a step toward a better comprehension of HyperStories rhetoric. Moreover, the high level design model and HHCASE provide some interesting advantages for designers without programming skills. They support the domain analysis, and consequently the evolution process from a story to a HyperStory, by providing a framework that facilitates an easier and exhaustive identification of different components of a HyperStory whitin a structured process.
From this perspective, we consider that some directions covering pedagogical-technical themes may be explored in further works. Some of these may be: 1) an enhanced version of both model and tool to cope with dynamic evolution of the HyperStory; 2) the improvement of the tool to better specify semantic relationship and to eventually introduce new relationships in a easy-to-use environment; 3) the use of HyperStories in different contexts as well as a much deeper formative and summative evaluation and 4) the construction of new tools covering the gap between the design and implementation process.

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From Class Aid to Job Aid, Can It Be Done?

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Abstract: This paper traces the process of repurposing a sophisticated multimedia CBT program, the "System for Training Aviation Regulations" (STAR), built originally for aviation maintenance technicians, into an on-the-job training aid for aviation safety inspectors. Three flexibility issues confronting curriculum developers are addressed within the context of this analysis and several conclusions are drawn from our experience with repurposing the STAR program.

Introduction

This paper traces the process of repurposing a sophisticated multimedia CBT program, the "System for Training Aviation Regulations" (STAR), built originally for aviation maintenance technicians, into an on-the-job training aid for aviation safety inspectors. Three flexibility issues confronting curriculum developers are addressed within the context of this analysis. These flexibility issues are:

- modifying the training program to fit a variety of training needs and audiences,
- keeping the training program current, and
- designing a program that continues to meet the needs of individuals as they mature into their job.

STAR-AMT

Target Audience

The training program for aviation maintenance technicians includes a course about the Federal Aviation Regulations (FARs) and document research. The material is dry, not intuitively organized, complex in presentation and content, and written in legalese. Instructors have few tools to make the material more vibrant and meaningful, relying heavily on reading passages out of the FARs and discussing their content. As a result, students tend not to see the relevance of what they are studying; they tend to bog down in the details, missing the big picture. The target audience has several defining characteristics. First, the target audience consists of students enrolled in a class usually in a college or high school setting. Second, most are new to aviation. It is within this instructional environment that STAR was developed.

Theoretical Approach

Multiple Vantage Points to Complex Information

There are two aspects to information complexity that have bearing on the instructional process. One is the relative difficulty of an individual concept. The other is the volume of information. In order to state "I understand this concept," or to say "I am an expert in this domain," one needs to be able to integrate components of a concept or domain into a scheme that can be readily demonstrated to others. A key factor to demonstrating conceptual understanding is the ability to identify relevant from non-relevant information. Conceptual schemes help to organize conceptual components and discern the difference between central and peripheral concepts. Taking multiple vantage points to a content area contributes to building conceptual schemes by providing overlapping information where the central themes tend to be repeated.

STAR-AMT is designed to help students acquire the "big picture" about what the FARs role is in Aviation. This is done through developing a conceptual scheme about how the FARs impact the daily tasks aviation maintenance technician's must perform and also what the aviation maintenance technician's role is with respect to complying with the FARs. This is accomplished, in part, by providing many vantage points to the same body of information. Experiencing complex material repeatedly under different circumstances provides multiple opportunities to gain a deep understanding of the subject [Spiro & Feltovich, 1991]. Each vantage point not only covers different aspects of the same material, but also reinforces different kinds of study skills. In this way, students are not only provided with multiple ways of viewing the information, but also with multiple opportunities to learn. In addition, information conveyed through one learning environment may best fit one student's style of learning, while the other learning environments fit other people's learning styles. Thus, more people benefit when multiple approaches to the subject are taken.

Learning in Context

Part of the difficulty in teaching the FARs is that students perceive the subject to be very dry. Indeed, some of the tasks expected of the students can be pretty tedious. However, there are many opportunities to convey the complexity and subtlety of the information in interesting ways. "War stories" from Aviation maintenance technicians currently out in the field is one way to make the material more interesting and meaningful to the student. Stories are well-suited for capturing tacit instructional knowledge, because storytelling is a more natural way for people to convey ill-specified practices [Chandler, 1994].

Another way to make the material more meaningful is to immerse the students in scenarios that confront them with "real world" decisions related to their jobs. By placing the application of the FARs in context, students have a much better chance of constructing for themselves a scheme [Brewer, 1987] for how the FARs operate functionally in aviation. When students are given the opportunity to learn in context, the concepts are acquired more rapidly, durably and are more easily transferred to new situations [Brown et al., 1989]. Both "story telling" and "situated learning" through scenarios place the information to be learned in contexts that the student can more easily relate to and remember.

Media-Rich Presentations

Media-rich presentations are a third approach to making the subject of the FARs more interesting. Multimedia has other pedagogical advantages as well. According to Park and Hannafin [Park, Hannafin, 1993], multiple, related representations improve both encoding and retrieval. Learning improves as the number of complementary stimuli used to represent learning content increases. For example, when concepts are encoded in both verbal and visual forms, they are retained in memory longer and are more easily accessed, because the two types of information complement each other in the activation, representation and development of related information [Park 1994]. Thus, complimentary information presented through multiple types of media is most favorable for conceptual retention.

The Learning Environments

STAR-AMT offers several different categories of learning environments: Overviews, Scenarios, Challenges, and Resources. Overviews give students the overall structure of the FARs and are best viewed first. Scenarios anchor [CTGV, 1992] students in real world situations, and Challenges are designed to promote the integration of material covered in the other learning environments, as well as provide students with a self testing mechanism for assessing their knowledge of the material. Resources are designed to augment and support the activities in the other learning environments. For a more complete description of each learning environment refer to the CD-ROM version of this paper.

The new challenge. Repurposing STAR for Aviation Safety Inspectors

New Target Audience; New Working Environment

In the beginning of April 1996, the STAR research team began to explore whether STAR could feasibly be reconfigured to address the on-the-job training of aviation safety inspectors. This is a very different target user group in a very different training environment. Aviation safety inspectors are experienced. Where the Aviation maintenance technicians were relatively young naive students new to aviation, aviation safety inspector's begin their inspection career after ten to fifteen years of experience in the field. They tend to be older. The average age of an aviation safety inspector is 45. They are specialists. Each aviation safety inspector specializes in one of the following areas: airworthiness, avionics, operations or cabin safety. Aviation safety inspectors are enforcers of the regulations. They must have an intimate understanding of the intent of the regulations and it is assumed that they do. Another significant difference between aviation safety inspectors and aviation maintenance technician students is that Aviation safety inspectors are working. Their primary concern is doing their job. Built into the job is an extensive on-the-job training program for both veterans and new recruits. Flight standards has a well established mentoring program for all new recruits and each new recruit must pass an exam for each inspection before they can perform that inspection unsupervised. Integral to the general atmosphere of pride among the aviation safety inspector community is a collective consciousness of how one should conduct oneself as an aviation safety inspector. This collective consciousness keeps regulatory conduct in the forefront and is vital to overall health of the community.

Despite the extensive on-the-job training program, there are problems. Aviation safety inspectors are expected to handle all types of inspections for all types of aircraft, not just their area of expertise. Veterans often feel hard-pressed to keep up with the field. It is easy to become rusty on inspections they do not do frequently. New recruits are busy learning through work. Because of extensive travel associated with the job, mentors are often not available to new recruits for consultation.

Description of STAR-ASI

STAR for aviation safety inspectors is composed of the same general components as the STAR program for Aviation maintenance technicians. Three of the learning environments, scenarios, resources and challenges, are identical functionally, with new content simply replacing old content. A new learning environment, Inspection Task Flow Charts, has been implemented in place of the Overview learning environment.

Inspection Task Flow Charts

Each inspection is considered to be a task. For their on-the-job training, the airworthiness group has developed task flow charts that show the logical steps for each inspection task, including decision points (e.g. Has a FAR been violated?). By simply implementing these flow charts on the computer, the STAR team has been able to leverage off of the visual representation of each inspection task developed by the airworthiness group to create an interactive version of that representation [Figure 1]. Now a new recruit not only has a visual representation of each inspection procedure, but also can investigate each step in the procedure. All other learning environments can be launched from each step in a task flow chart. Depending on the instructional objective, one has the option to ask a quiz question, show what a form looks like, attach relevant passages from an Order or a FAR Part, comment on what an inspector's responsibilities are, or create a mini scenario. Task Flow Charts give each inspection procedure a structure; the dynamic nature of the computer provides informational depth to that visual structure.

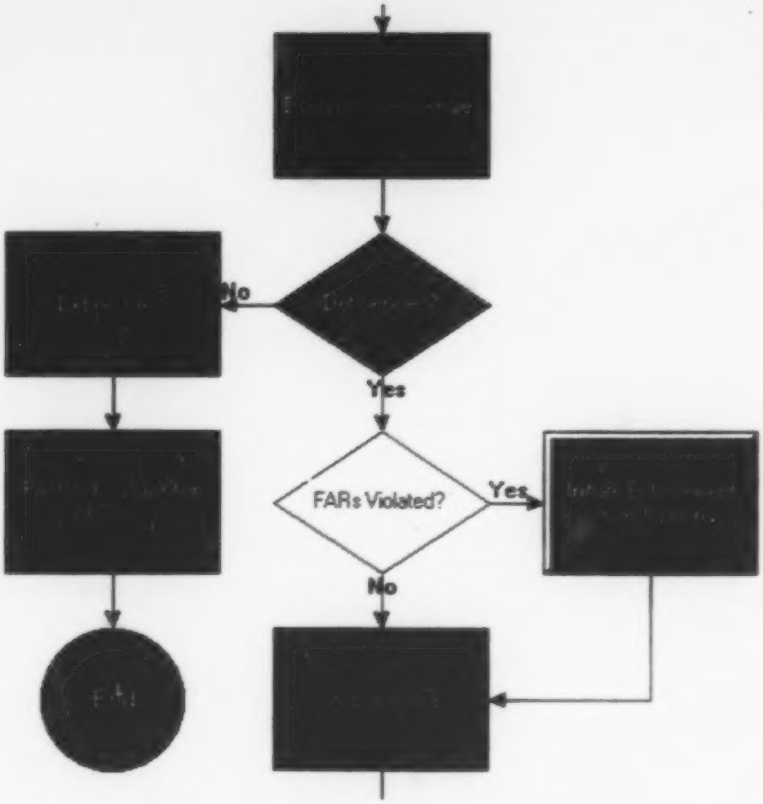

Figure 1: Inspection Task Interactive Flow Chart

The Emphasis

Based on task analysis and numerous discussions with Aviation safety inspectors the team decided that scenarios are best suited for situations where:

- there is a significant amount of interaction between people,
- there are several plausible ways a person can respond to a situation,
- individuals must draw upon a significant amount of their resources or understanding of the situation in order to make the best decision, and
- choosing a wrong answer does not necessarily terminate the story.

The STAR team found that scenarios were much easier to generate for maintenance than inspections. Part of this may have been due to the characteristics of the people who provided the scenarios; part of this had to do with the nature of the two domains. Stories generated for maintenance tended to be about a job that needed to be done and what considerations needed to be made in order to complete the job legally. Many interesting situations could be woven from doing a major repair or conducting a 100 hour maintenance inspection. The story tellers being instructors was another advantage. Part of their job involves weaving stories to make salient points about aviation concepts. Inspectors are more procedurally oriented. They can easily generate "what if" questions (e.g. What if the captain does not have his medical certificate? What if the first aid kit is not sealed?) but often these questions terminate the story with a violation. The highly procedural and primarily linear nature of inspections make weaving an interesting and authentic story more difficult.

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Interactive Task flow charts have become the center piece of STAR for Aviation safety inspectors in place of scenarios. Because inspections are so procedurally oriented, task flow charts best represent what an inspector needs to consider when doing a particular inspection. Interactive Task Flow charts have certain curricular advantages. They can function as a reference, as well as a guide. In the simplest instance, a step may just have commentary or it may have sample forms available to remind Aviation safety inspectors of what the forms look like and for what purpose they are used. Sections of Orders and FARs relevant to that step (and only those sections) are attached for the Aviation safety inspectors perusal. Where appropriate, the document is structured and highlighted to reveal its most salient points. Legacy data is removed for clarity. These simple features allow Aviation safety inspectors to review the most salient points and information associated with any given inspection.

From Training Aid to Job Aid

For STAR-AMT, resources augments and supports training; for STAR-ASI, the emphasis is reversed - training augments and supports resources [Duchastel et al., 1995-96]. Even in the context of on-the-job training, the primary activity and concern of each aviation safety inspector is having the right information at the right time to do his or her job well. Sometimes that may be learning how to conduct oneself during an inspection; other times it may be reminding the aviation safety inspector which forms are needed for a particular inspection. In either case, STAR is designed to handle both needs. Task flow charts, for example, organize the information into a logical structure. This structure can be used in several ways, depending on the experience of the user and his or her present needs. For a new recruit, the flow chart is a training aid that he or she can step through, see the organization of the inspection, quiz him or herself, look up terms or read relevant documentation; he or she can view what sample forms and review how and to what purpose they are used. A veteran can review the steps of an inspection not done in a while before venturing out into the field. Or they might use it purely as a reference to look up which form they are suppose to use or the meaning of that acronym they never really learned. Scenarios which target new recruits more than veterans might never be touched by veterans. However, a mentor might employ the scenarios as a vehicle for discussions with new recruits.

Keeping Current

In the working world where documents are living and policies change, it is vital to create a CBT that supports this environment. Information and training should be designed so that they can be updated and changed easily. This means a more compartmentalized approach. If a step in the flow chart is no longer relevant, only that part should be changed, not the whole structure. In situations where compartmentalization of information is difficult, as is the case of a long involved scenario, the content should not focus on particulars that are likely to change. Rather, themes such as ethical conduct or procedural issues should be addressed. How one debriefs an organization after the completion of an inspection, for example, addresses an important theme about conduct that effects all inspections and whose message is unlikely to change over time.

Living documents, especially if they are expected to retain legacy data, can be difficult to maintain. It is this kind of information that will date a training system. Electronic publishing techniques could help maintain this kind of information. Electronic publishing structures textual information for different views so that the most relevant points are accessible for a particular audience . For example, legacy data can be hidden behind hypertext references. The history of the document is preserved but it does not obstruct the presentation of the most recent version of the document for training or review.

Conclusion

Four conclusions can be drawn from our experience with repurposing the STAR program. First, it is much easier to build a resource that incorporates training than to build a trainer that some how metamorphoses into a job aid. Second, the system needs to be highly modular. In STAR, for instance, each learning environment (e.g. Resources, Scenarios, Challenges) is self contained; as is each learning module (e.g. the Glossary, the Cabin Enroute Inspection Scenario, the A & P Task). One can swap out a training module, a learning environment, or a reference guide depending on one's training or job aiding needs. Third, applying a browser approach to interface design increases the options for how the system can be used. STAR's browser style interface gives the system the flexibility to be a presentation aid, a self paced tutor or a reference utility. It is not bound to a lock step tutorial approach. Modularity and a browsing style interface give STAR maximum flexibility for accommodating different training and job aiding objectives. Finally, electronic publishing may offer some solutions for training systems that rely on living documents as the basis of their training, but the ongoing battle to keep training programs current will continue to be a battle for curriculum developers.

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The Learning Flow and Portfolio Management for Distance Learning Environment on Web

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Abstract: In this paper, we propose a model for managing the learning flow and portfolio to scaffold learners and promote learning efficiency of distance learning environment on World Wide Web. Users' requirements depict the difficulty to promote learning performance when we constructed distance learning environment on network tools. New network technologies attract instructors to adjust the system architecture for better learning performance frequently. Furthermore, designing distance learning environment on existing network tools always made additional burden for instructors and learners. For instance, it may request an instructor to master the network tools for developing distance learning environment and students should pay attentions to acquire the environment. To improve the problem thoroughly, the learning flow and portfolio management of distance learning environment can enable an instructor to scaffold and observe learners' behavior effortlessly. This paper presents a generic framework as well as a software prototype for managing learning flow and portfolio on Web. The framework can promote learning performance, avoid continuous adjusting system, and reduce users' burden.

Introduction

Existing distance learning systems use network tools for educational telecommunication. However, regardless of how good a distance learning system designs, the learning performance mostly depends on learners' interests to the distance learning system. Owing to the popularity and easy access of the computer network and associated communication tools, network facilities can be incorporated into a distance learning system. For instance, learners in a distance learning system can learn by reading hypertext learning materials, discussing, or asking questions through the computer network. Consequently, we applied network tools on the Introduction of Computer Science course to promote learning performance of a realistic class. The initial purpose was to scaffold students by answering questions and to observe students' learning problems on distance. At the beginning, students used mail list to communicate because every student had a UNIX account and electronic mail can 'server as a foundation for strengthening interstudent communication.' [Wissick *et al.*, 1995] The communicating method of mail list is broadcasting to memberships of the mail list by electronic mail. Consequently, all memberships receive all questions and answers by electronic mail. Some teaching assistants were responsible for answering questions because we did not expect others will answer a beginner's questions. We cheerfully found that some students answered trivial questions frequently. Applying mail list did provide students an additional way to learn on distance. However, some problems occur when using group learning strategies to promote the leaning performance of the class. The problems include: (1)*Lack of learning activities for increasing participation.* We tried to increasing students' participation because many students never joined discussion by mail list. We inquired those students and found that most of them are afraid of asking a trivial question or providing an incorrect answer. We divided students into groups for studying topics and sharing reports to resolve this problem because researches revealed that learning performance of a group learning environment depends on proper learning activities [Bricker *et al.*, 1995]. However, applying group learning strategy on existing distance learning system must suit to network tools. (2)*Lack of learning flow for scaffolding learners.* Although mail list facilitates teachers to answer students' questions, mail list can not specify a flow to scaffold learners. For instance, a teacher may want students to submit their homework by email after students familiarized with discussion by mail list. Ideally, students' homework should forward to teaching assistants for correcting. Then, teaching assistants reply a electronic mail with correction of students' homework to students. Finally, students should send back the refined homework to teaching assistants. However, mail list does not enforce that kind of learning flow. The prime causes of the problem become evident when using Web to improve the discussion style of mail list. Many network tools on Web, for instance hypermail[1], can arrange mail in a more constructed style. Although Web can implement some learning techniques, for instance the guided tour for courseware [Hauck, 1996], and footsteps for a quiz activity [Nicol *et al.*, 1995] so on, these learning techniques arose a common problem — learning flow beyond control. Johnson (1996) used state to resolve the problem, but it did not show how to resolve it on Web. (3)*Lack of behavioral records for promoting learning efficiency.* Web can server as an excellent media of group learning for distant, statistic, and asynchronous communication. However, the information is not enough for an instructor to figure out the relationship between students' behavior and learning performance. Many educators think that learners' behavior records, called *portfolio*, is very important for assessing learning performance [Paulson, 1991; VanLeirsburg, 1990]. However, existing distance learning systems do not have a tool for instructors to create the portfolio of every learner. As distance learning has become more prevalent on Web, attention has been given to manage users' behavior in distance learning. Albatross [Yeh *et al.*, 1996] uses synchronous navigation control to avoid learner-centric phenomenon. In other words, learners are free and active in their learning process, while instructors can not put constraints to learners' behavior. Some techniques can partially promote learners' learning efficiency, for instance guided tours, path mechanism [Zellweger, 1989], footsteps, etc. However, those techniques require records of learners' behavior.

To sum up, a distance learning environment wholly depends on Web will lack some essential elements of group learning to satisfy users' requirements, for instance learning activity, learning flow, portfolio etc. For instance, the temporal issue must be considered to construct a quiz activity. Then an instructor can specify the beginning time and duration of a quiz activity. Additionally, a teacher should be able to efficiently find out students' answers of specific questions in a quiz activity. Consequently, the designing model must embed the fundamental mechanisms, including learning activity construction, learning flow definition, and portfolio management, to precisely satisfy an instructor's requirements for designing a distance learning environment on Web.

Motivating Example

Here is a motivating example to depict how the system operates for designing a distance learning environment. The scenario of the motivating example describes a quiz activity followed with discussion activities. [Fig. 1] illustrates following narration of the scenario.

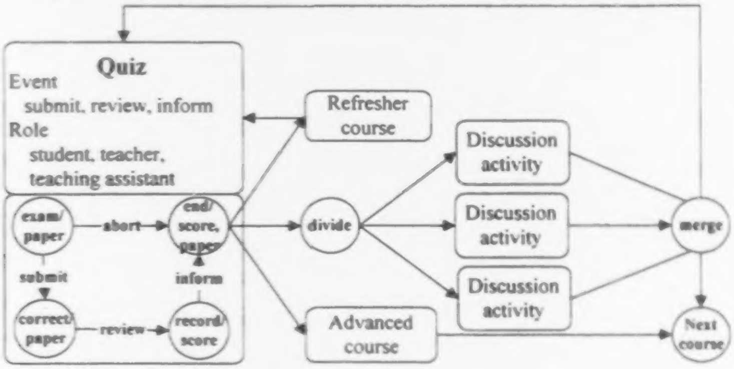

Figure 1: The motivating example.

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[1] Http://www.eit.com/software/hypermail/hypermail.html

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(1)*Constructing the quiz activity*: For instance, an instructor should define roles and events of an activity. The roles involved by the quiz activity include teacher, teaching assistant, and student. The events triggered by the quiz activity include submitting an assignment, reviewing the corrected paper, informing a student, aborting the quiz. (2)*Defining learning flow*: Both learning flow in the quiz activity and learning flow among activities must be defined. In the scenario, the learning flow in the quiz activity includes four states, that are exam, correct, record and end. [Fig. 1] illustrates transition mechanism of the four states and output of each state. Furthermore, the following activity of the quiz activity is assigned by one of the subsequent activities, that is refresher course, discussion activity, and advanced course, according learners' score of the quiz activity. (3)*Querying learners' behavior*: First, an instructor can observe the learners' behavior in an activity. For instance, an instructor may want to figure out the relationship between score and duration of the exam state in the quiz activity. Second, learning flow will implicitly imply learners' learning style. An instructor may want to figure out learners' learning style from the learning flow in and among learning activities. For instance, an instructor may in interested in "did a learner abort a quiz?", "how does a learner join the advanced course?".

Construct Learning Activities

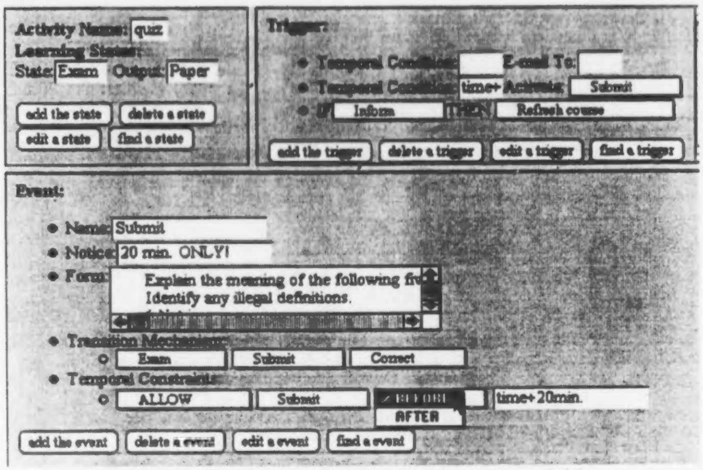
An *activity* is composed of a set of *events*, a set of *triggers*, and a set of *roles*. For example, an instructor may arrange a discussion activity. The activity has three roles involved: teacher, moderator, and students. The teacher assigns a topic for discussion. The students can submit opinions of the topic to the moderator. The event of submitting opinions defined a procedure to store opinions into data repository. Other students, moderator, or even teacher may reply an opinion. The system should notify the moderator to make arrangement of the opinion if an opinion does not be replied more than two days. In the above mentioned activity, teacher, moderator, and students are *roles*. Assigning topic, reading opinions, and submitting opinions are *events*. Automatic notification is a (temporal) *trigger*.

To define an event, a user should define the following items of an event: (1) notice, (2) form, (3) transition mechanism, and (4) temporal constraint. The notice part contains the advice of this event. For example, the notice item indicates the valid duration of the submitting event in a quiz activity. The form part describes the information required to be submitted back. For example, the submitted paper for a quiz activity should contain the name of the student, the ID of questions, and the answers. The transition mechanism describes how the event changes learning state in an activity. The temporal constraint part defines when to complete the event.

A trigger is used to initiate events. For example, the trigger of submitting paper event will initiate the defined procedure of the event to store the submitted papers. A trigger should define the conditions to initiate an event. The types of the condition to initiate an event include data exchange, role constraints, and temporal restriction. The trigger of data exchange type was used in database systems [Gehani & Jagadish, 1991]. Because Web can easily integrate with databases, triggers of an activity are consequently feasible by database.

A user table is required to describe all the information of the users and all the default roles of the users in an activity. For each activity, a particular role may be assigned to a user. Sometimes, we also define groups for an activity and assign a user in a group a particular role. For example, a teacher may want to divide a C++ homework into four tasks: problem analysis, object definition, object implementation, and object integration for the answer of a problem. Each task is done only by a particular role. Thereafter, we form groups from the students and assign a role for a student of each group to do the particular task.

A finite state machine can represent the *learning states* of a learning activity. A finite state machine is composed by states and transition mechanism. A state is represented by a fill-out form on Web. Users can only access the fill-out form through the transition mechanism. The transition mechanism is composed by CGI programs of the fill-out forms. The CGI programs will cause the transition from one state to another. The *portfolio* of a learning activity is composed with output of a learning state with time stamps, logs of events with time stamps, and users' duration of a state. In other words, users' inputs on a state by the fill-out form are attached with a time stamp as portfolio. Although the portfolio is a mine of pedagogical meanings, it is difficult for a teacher to figure out the pedagogical meaning from the portfolio. Consequently, portfolios are stored into a database so that one can easily query requiring portfolio. [Fig. 2] illustrates the interface to construct learning activities. The upper left corner of [Fig. 2] let an instructor to manage the learning state by adding, deleting, editing and finding a state. The upper right corner of [Fig. 2] manages the trigger of the activity. The bottom event of [Fig. 2] defines the event, transition mechanism and temporal constraints. The group and role of the interaction part is control by Web server. Consequently, only the right users can access the right pages.



Activity Name: quiz

State: Exam Output: Paper

- Temporal Condition: E-mail To:
- Temporal Condition: time+ Activate: Submit
- IF Inform THEN Refresh course

- Name: Submit
- Notice: 20 min. ONLY!
- Form: Explain the meaning of the following fr
  Identify any illegal definitions.
- Transition Mechanism:
  - ○ Exam Submit Correct
- Temporal Constraints:
  - ○ ALLOW Submit BEFORE AFTER time+20min.

Figure 2: The interface for designing learning activities.

Define Learning Flow

To scaffold learners, an instructor must guide learners' learning flow among learning activities. Users have mutual obligation to accomplish a task after a distance learning environment can construct a learning activity. For instance, a teacher must prepare problems of a quiz, define the duration of a quiz, and arrange a proper chance to hold a quiz. A student must study the course of a quiz, participate a quiz with temporal pressure, and submit paper of a quiz to teaching assistants. Although learning activities can increase learners' participation, they can not guide learners with a sequence of learning activities. In other words, a distance learning system should guide learners not only in activity, but also among activities. For instance, a refresher course should tag after a quiz activity if the score of a student is low. A discussion activity should tag after a quiz activity to figure out students' misconception. Learning flow among activities can bind various learning activities in a distance learning environment.

The relationships among learning activities must be defined so that users can always learn with a suitable role. However, using finite state machine to represent the learning flow is not sufficient to reserve the concurrent sequence among learning activities. For instance, many discussion activities are going after a quiz activity. Consequently, the following operators are used to represent requiring learning flow among learning activities: (1)*Linear learning*. Linear learning means that a subsequent learning activity follows a prior learning activity. The SEQUENTIAL operator can define the basic sequence of learning flow. For instance, students can join the next course after finishing the advanced course. This situation can be defined as "advanced course SEQUENTIAL next course." (2)*Branching learning*. Branching learning means to activate the demanding subsequent learning activities according portfolios of a prior learning activity. There are two kinds of branching learning operators: AND-Split operator and OR-Split operator. The AND-Split operator indicates that the subsequent learning activities are synchronous activated. For instance, students participate different discussion activities after a quiz activity in the scenario of motivating example. The upper part of [Fig. 3] represents the scenario as "divide AND-Split group1 discussion", "divide AND-Split group2 discussion", and "divide AND-Split group3 discussion". The lower part of [Fig. 3] shows the learning flow in a graphic style. The OR-Split operator indicates that only one subsequent learning activity is activated by evaluating the portfolio of the prior learning activity according to the condition of branching. For instance, either advanced course, discussion activity, or refresher course are selected as the subsequent activity according score of a quiz activity. (3)*Learning coordination*. Learning coordination defines how learners coordinate with each other after branching learning. Join operators are used to represent the conditions of learning coordination. Join operator indicates that many prior learning activities coordinate for a subsequent learning activity by evaluating the portfolio of prior learning activities. Sometimes the outcome or the result of coordinated activities is dependent. This AND-Join operator can define the condition, that the subsequent learning activity is activated only after all the prior learning activities are finished. OR-Join can define the racing situation of many learning activities. In other words, any prior learning activities can activate the subsequent learning activity when any prior learning activities have finished. (4)*Iteration*.

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The operator defines the iteration of learning flow. For instance, unqualified students will iterate refresher course and quiz activity. The iteration of learning flow differs from repeating practice in CAL because the iteration of learning flow will activate a learning activity with students' portfolio. Consequently, the content of a learning activity will change with students' portfolio.

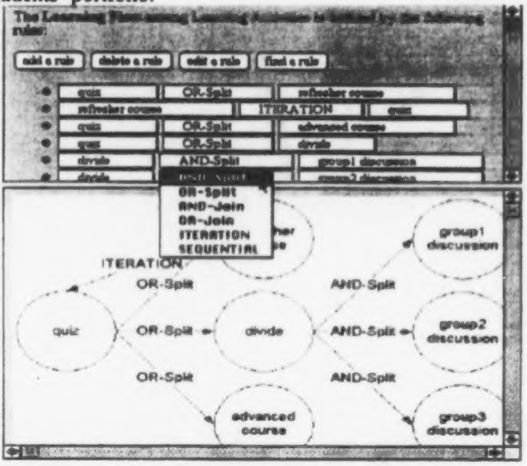
add a rule
delete a rule
edit a rule
find a rule
quiz
OR-Split
refresher course
refresher course
ITERATION
quiz
quiz
OR-Split
advanced course
quiz
OR-Split
divide
divide
AND-Split
group1 discussion
divide
group2 discussion
OR-Split
AND-Join
OR-Join
ITERATION
SEQUENTIAL
ITERATION
OR-Split
OR-Split
OR-Split
quiz
divide
advanced course
AND-Split
AND-Split
AND-Split
group1 discussion
group2 discussion
group3 discussion

Figure 3: The interface for learning flow definition.

Portfolio Management

Learning activities accumulate a large amount of portfolios. Retrieving the meaningful information from the portfolios is difficult for an instructor without an effective query method. However, comprehending learners' behavior from the portfolios is very important in a distance learning environment. Using hypertext to navigate for specific data is not a suitable method to query specific data, for instance structural data, temporal data, etc.. Furthermore some educators [Arter & Spandel, 1992] recommended that a portfolio assessment must be carefully designed. Consequently, we do not propose a method to assess students' portfolio. Instead we propose tools for an instructor to retrieve meaningful information from learners' portfolios.

Learning flow endows the portfolios additional meanings, for instance temporal data, sequential order, social interaction. Traditional query language, such as SQL, can not effectively query those data. In our model, there are three cues to observe learners' specific behavior, including portfolio, learning flow, and event trace. An instructor can mine useful information about learners' behavior from the following queries. (1)*Portfolio query*. Students' specific behavior must be represented as proper style to query it from a large amount of portfolio. After using finite state machine to represent the learning flow of a learning activity, an instructor can easily retrieve learners' specific behavior from the portfolio by the learning flow expression. The notation of the expression is "SELECT output FROM state IN activity WHERE condition." For instance, one can query the corrected paper of the quiz activity by the pattern "SELECT papers FROM correct IN quiz WHERE user's name=chen." The left upper corner of [Fig. 4] illustrates the portfolio query. Note that a quiz activity may follow many different courses so that a learner's portfolio of a quiz activity would accumulate with time. The temporal condition in the WHERE clause enables instructors to figure out learners' temporal change in portfolio. (2)*Learning flow query*. In contrast to the learner-centric management in portfolio query, learning flow query provides an activity-centric method to figure out learners' behavior. Instructors usually need to find out the learners with some specific learning activities flow structure, that is "activity1, activity2, activity3, ...". For instance, a teacher may want to list the students with the following learning history: 1. Join a quiz activity, 2. Join a refresher course, 3. Join a quiz activity, 4. Join an advanced course. The right part of [Fig. 4] shows the result of the learning flow query in the left second row of [Fig. 4]. (3)*Event trace query*. Event trace indicates how a user's state changes from one state to another state. Event trace is important for an instructor to understand a learner's learning style. For instance, a teacher may want to query how the learning state changes from the correct state in a quiz activity to the scaffold state in a refresher course. The query result can indicate a learner's learning degree of reflection by the time interval between submit a paper and start a refresher course before informing about score. A learner's degree of reflection may be high if the event trace is the form "submit - abort -...- inform ...".

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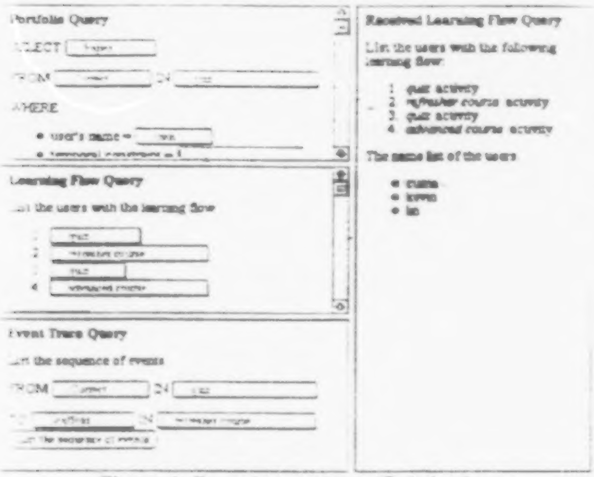
Portfolio Query
SELECT
FROM
ON
WHERE
user's name =
Learning Flow Query
List the users with the learning flow
Event Trace Query
List the sequence of events
FROM
ON
Received Learning Flow Query

List the users with the following learning flow:

1. quiz activity
2. refresher course activity
3. quiz activity
4. advanced course activity

The name list of the users

- cuma
- kevin
- lin

Figure 4: Query learners' specific behavior.

Conclusion

To promote learning efficiency of a distance learning environment, first we depict the requirements to managing the learning flow and portfolio of a distance learning environment on Web. To satisfy the requirement, an ideal model for designing distance learning must be able to construct learning activities, define learning flow, and query specific behavior. We proposed a designing environment that an instructor can use a friendly interface on Web to construct learning activities, define learning flow, and query specific behavior. We use a motivating example to depict how the model operates with available technologies. Consequently an instructor, who developed distance learning on Web, can benefit their learning environment from the designing methodology without additional burden. Most important advantages of the model, that is managing learning flow and portfolio, enable an instructor to precisely observer learners' interaction in a distance learning environment on Web. We showed that available technologies can support the designing model for an instructor to design and implement the learning environment for better learning performance.

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Awareness and Virtual Cooperative Interaction in the Learning Web

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ABSTRACT The article investigates *awareness* issues involved in the learning web. It presents a conceptual model for *virtual cooperative interaction* and examines how one would ensure the continual participation and contribution by information providers to the web. For example, a virtual art gallery on the web has an *intensional expectation* of its potential audience: guest artists often contribute in order to gain recognition from peers; and its webmaster can gain satisfactions via receiving popular site awards (e.g., "the best website for cubism"). The example involves social psychological processes which instigate and maintain *virtual cooperation*. These processes can be analyzed by the motivational and reinforcement aspects of the conceptual model. These phenomena are common in existing activities such as those of scientific research communities and those of emerging learning communities on the Internet.

1. INTRODUCTION

The 1990s have seen the emergence of large scale collaborative activities on the Internet using email, list servers, news groups and the World Wide Web. There have also been developments of systems using some of these technologies to support smaller closely-coupled collaborative learning groups. In terms of the standard time/space taxonomy for CSCW (computer-supported cooperative work), these uses of the Internet are generally virtual in space and range from highly synchronous to highly asynchronous interactions. However, many of the major applications of the Internet raise new issues that are not adequately addressed by existing models and taxonomies of CSCW. Small groups of individuals working together generally have well-defined roles and mutual awareness of roles, tasks and activities. However on a list server, a discussion may be initiated with only a vague concept of other potential participants but with strong expectations that a collaborative activity will result. On the World Wide Web material may be published without only a vague conception of potential users yet that material may play an essential role in a collaborative active in some community, possibility not involving the originator, and perhaps a community of which the originator is not part.

The web was originally conceived and developed at CERN for the purpose of assisting and facilitating collaborative interactions among high energy physicists, working at various institutions in different countries, to conduct joint research projects. Since 1993, it has diffused at a phenomenal rate and gradually has subsumed various popular Internet services such as: USENET news group, electronic mail, etc. The original charter of the web is summarized in the following quote: *The World Wide Web was developed to be* ***a pool of human knowledge****, which would allow collaborators in remote sites to share their ideas and all aspects of a common project* [Berners94].

The notion of the **learning web** was presented at EdMedia '95 as: *a systemic approach to the modeling and support of knowledge processes in a learning society* [Norrie95]. This paper develops a model of virtual cooperative interaction and the support of awareness in the learning web. In carrying out cooperative learning, learners use a variety of tools. The proliferation of **computer mediated environments** (CMEs, e.g., conferencing systems, shared media space) allows learners to utilize the new resources for their cooperative interactions. CSCW or groupware systems are often classified as supporting either synchronous or asynchronous cooperative interactions; but this simple distinction fails to capture the complexity of large scale collaborative work. Typical groupware supports cooperative interactions ranging from small closely coupled team numbering 2-5 people (e.g., co-authoring systems [Neuwirth94]) to large group of participants numbering 50-100 (e.g., electronic meeting systems [Dennis90]). However there is now an emergence of *large scale groupware* on the Internet and World Wide Web, with participants numbering in hundreds or thousands.

2. THE LEARNING WEB AS SOCIOWARE

The diffuse collaborative communities that have formed on the Internet suggest the need to reconsider existing notions of CSCW. Large scale groupware differs not only in the quantity, but also in the quality of cooperative interaction. The fundamental nature of interaction on the web can be characterized as **virtual cooperative interaction**. The word "virtual" has two senses here: first, it denotes the notion of *virtual space*, i.e., the cooperative interaction occurs in a non-physical space which allows participants to be situated in geographically separate locations; second, it denotes that the *intention* to engage in cooperative interaction itself may not necessary pre-exist or be conscious. Traditional notions of groupware focus on the first sense (tele-presence in virtual space), but there is a need to extend the notion of cooperative interaction to encompass the latter sense of virtual cooperative interaction also.

Frequently, information resource contribution and exchange on the web involve cooperative interaction without pre-planned coordination. In fact, participants on the web may have no intention to cooperate in the first place. Quite often, a resource provider and a resource user are unaware of each other's existence until their first interaction. Nevertheless, the interactive process between them is still loosely cooperative in nature. It is an unusual form of cooperation where a resource provider might never know the identity of her resource users, nevertheless still continues to contribute anyway. It differs from the traditional team-oriented cooperation where group tasks, goals, and purposes are usually well-defined. What does she gain in return in such a seemingly one-way cooperative interaction? Is it simply an expression of altruism? What are some possible motivations for her to contribute to the web? In general, how would one ensure the continual contribution of an information provider? These questions can be answered more clearly in the context of *socioware*.

The present paper defines **socioware** as: *computer-mediated environments for supporting community-wide processes which expedite virtual cooperative interactions*. Information inquiry and response, dissemination of ideas, and social networking are examples of functionality of the learning web [Norrie95]. In essence, the goal of socioware is to facilitate emergent pro-social behaviors for self-organized, virtual collaborative communities. This paper models the Internet as a whole (the web/net) as large scale socioware supporting cooperative interactions which differ qualitatively from goal directed, highly coordinated team-oriented collaborations supported by conventional groupware.

3. CONCEPTUAL MODEL OF THE LEARNING WEB

This section describes a detailed learning web model that encompasses collaborative activities supported by traditional groupware and by emergent socioware. The model analyzes the following five basic elements for the learning web in terms of virtual cooperative interaction:

1. *discourse patterns*
2. *time-dimension of virtual interactions*
3. *awareness hierarchy*
4. *motivations for cooperative behaviors*
5. *emergence and maintenance of virtual cooperative interaction*

Together they present three aspects (what, why, and how) of the conceptual model: (i) the descriptive aspect comprised of the first three elements which characterize and classify virtual cooperative interactions; (ii) the prescriptive aspect that provide motivational reasons for individuals to participate in virtual cooperative interactions; and (iii) the operational aspect of how virtual cooperative interactions initiate and function.

3.1 Discourse in Virtual Cooperative Interaction

Communication is an essential element of cooperative interaction. Generally speaking, there are two types of communications on the Internet, namely: *discourse* and *publication*. This subsection proposes a temporal punctuated-discourse model of virtual cooperative interaction which models both modes in an integrated way.

3.1.1 A Punctuated Discourse Model

A conventional taxonomy of Internet might describe its services in terms of their utility, but it does not provide an integrative model of the way in which they support communities. Such a model can be developed by noting that what distinguishes discourse from publication is that in discourse it is expected that the recipient responds to the originator, whereas publication is generally a one-way communication. However, on list servers some material is published in that the originator expects no specific response, and material published in electronic journals or archives often evokes a response. The following diagrams show the different characteristics of the main Internet services in terms of these issues.

Figure 1 shows email discourse as a cycle of origination and response between a pair of participants communicating through a computer-mediated channel. Figure 2 extends Figure 1 to show list server discourse as a cycle of origination and response between participants that is shared with a community through a computer-mediated channel. The community involvement leads to more complex discourse patterns in that: the originator may not direct the message to a particular recipient; there may be multiple responses to a message; and the response from the recipient may itself trigger responses from others who did not originate the discourse. For a particular discourse sequence this leads to a natural division of the community into active participants who respond and passive participants who do not.

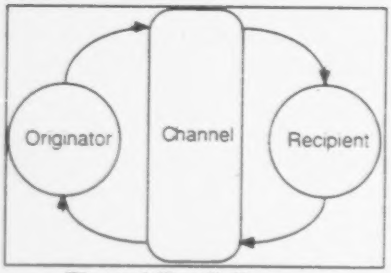

Figure 1 Email discourse

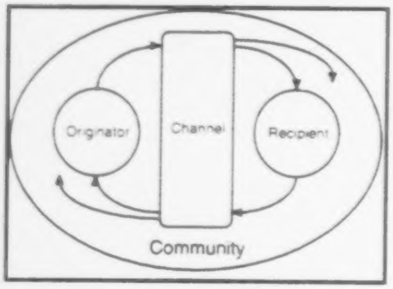

Figure 2 List server Discourse

Figure 3 modifies Figure 2 to show web publication as an activity in which the channel is buffered to act as a store also. The material published is available to a community and the originator is unlikely to target it on a particular recipient. Recipients are not expected to respond direct to the originator, but responses may occur through email, list servers or through the publication of material linked to the original. Because the published material is not automatically distributed to a list, recipients have to actively search for and discover the material. The common structure adopted for the diagrams is intended to draw attention to the commonalties between the services. List server discourse is usually archived and often converted to Hypermedia on the web. Web publications do trigger responses through other services or through links on the web. A search on the web may not discover a specific item but rather a related item on a news group, list or by an author, and result in an request for information to the news group, list or author. Individuals and communities use many of the available services in an integrated way to support their learning processes. Figure 4 subsumes Figure 1 through Figure 3 to provide an integrated model of the learning web on the Internet that captures all the issues discussed. It introduces two major dimensions of analysis: the *times* for each step in a discourse cycle; and the *awareness* by originators of recipients and vice versa.

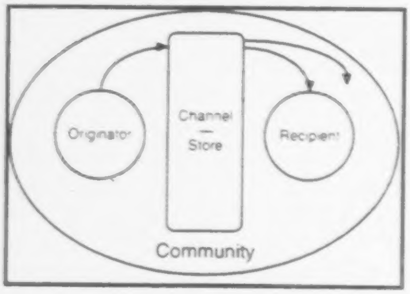

Figure 3 World Wide Web Publication

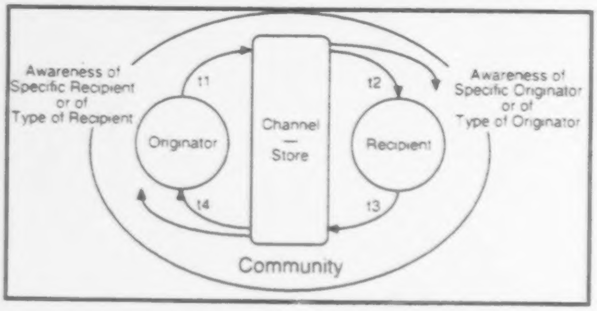

Figure 4 Punctuated Discourse

3.1.2 Time-Cycle of Punctuated Discourse

The four times shown in Figure 4 are:

- t1: the origination time— the time from a concept to its expression and availability
- t2: the discovery time— the time from availability to receipt
- t3: the response time— the time from receipt to expression and availability of a response
- t4: the response discovery time— the time from response availability to receipt

Note that individual's cognitive processing times and channel delays have been lumped. A study focusing on the impact of communication delays would want to consider them separately, otherwise there is no significant distinction. A general principle might be that communication delays should not be greater than individual's cognitive processing times. Note also that the diagram is to a large extent symmetrical— the recipient becomes an originator when responding.

An important overall parameter is the round-trip discourse time, t1+t2+t3+t4. The **time-cycle** of virtual cooperative interaction is defined by averaging the round-trips of discourse times. If this is small, a few seconds or less, we talk in terms of synchronous communication. If it is large, a few hours or more, we talk in terms of asynchronous communication. If it is infinite, so that there is no response, we talk in terms of publication. However, this analysis shows that there is a continuous spectrum from synchronous through asynchronous to publication. The discovery times, t2 and t4, are very significant to publication-mode discourse, and attempts to reduce them have lead to a wide range of *awareness-support tools* that aid potential recipients to discover relevant material and originators to make material easier to discover [Gaines96, Chen96].

3.2 The Time Dimension in The Learning Web

When two or more individuals participate in the learning web, they often take on dual roles of originator and recipient in punctuated discourse. Gradually they become locked into *social entrainment processes* [McGrath90]. Computer-mediated environments, such as news groups and shared drawing systems, provide specific external signals which set the pace of virtual cooperative interactions for participants. For example, the average *time-cycle* for posting to a news group and receiving a feedback is about one to few days. Whereas the partial time-cycle (t1+t2) for moving a mouse cursor in a real-time shared drawing system is around one to ten seconds. *External entrainment* [McGrath90] occurs when the *actual* time-cycle of a virtual interaction fall into the range of the *expected* time-cycle anticipated by individual participants. When there is a wide discrepancy between the expected and the actual time-cycle of interaction, participants often feel frustrated and decrease their desire to interact. For example, if cursor movements in a shared drawing system begin to take more than a few seconds to complete, the participants will tend to stop their interaction.

Continuation of virtual cooperative interaction can also break down when *mutual* and *external* entrainment processes are not synchronized with one another [McGrath90]. When co-reviewing a book, the natural time-cycle for mutual entrainment is in days and weeks, since it often take that a mount of time to read a book and absorb the material properly. It is unlikely that co-reviewers will want to use IRC (Internet Relay Chat) to disseminate and exchange their reviews. Such a fast time-cycle of interaction is not well suited for activities involving deep, reflective cognitive processes.

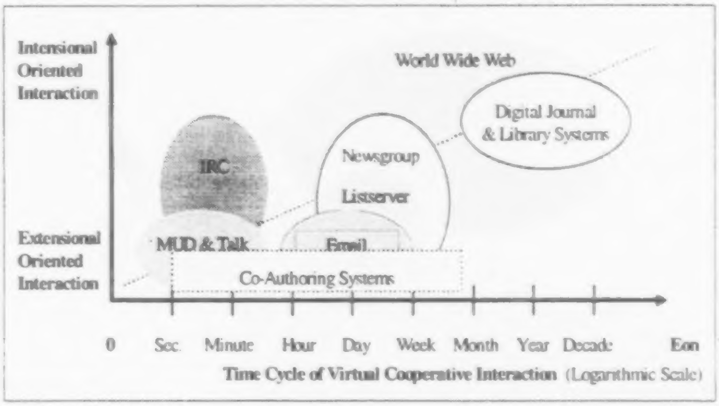
Intensional Oriented Interaction
Extensional Oriented Interaction
World Wide Web
Digital Journal & Library Systems
IRC
Newsgroup
Listserver
MUD & Talk
Email
Co-Authoring Systems
0
Sec.
Minute
Hour
Day
Week
Month
Year
Decade
Eon
Time Cycle of Virtual Cooperative Interaction (Logarithmic Scale)

Figure 5 Time Dimension of Virtual Cooperative Interaction

The time-cycle in the learning web often varies according to cognitive processes involved in any given moment of an activity. For example, during a collaborative writing session [Neuwirth94]: when co-authors' focus is on correcting sentences or paragraphs, the time-cycle involved is usually around few minutes; and when they focus on reviewing chapters, the time-cycle involved shifts to hours. Therefore co-authoring systems are classified in the range of time-cycles from second to day, in addition to be extensional oriented. The time dimension diagram of virtual cooperative interactions allows us to visualize CMEs in terms of an *interaction area* they encompass as shown in Figure 5.

Many groupware systems have been designed to support collaborative teams in which interactions are between known group members. In contrast, interactions in USENET news groups involve both extensional and intensional awareness of targeted audience. For example, one can respond to a question from a specific individual (an extensional oriented interaction) but do so publicly with the intention to address others who may have a similar question in mind (intensional oriented interaction). The relationship between the time-cycle and the relative strength of *extensional/intensional awareness* in the learning web can be illustrated in a time-dimension diagram (Figure 5). If the time-cycle is relative short, say in few seconds or minutes, we have an interaction that can be characterized as synchronous (real-time). If it is longer, we have interaction that is often described as asynchronous (delay-time).

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	Team	Special-Interest Community	Community at Large
Resource Provider	Extensional awareness of actual users.	Intensional awareness of types of users.	No awareness of users, or only weak intensional awareness of types of users.
Resource User	Extensional awareness of actual resources and providers.	Extensional awareness of actual resources and providers, or intensional awareness of types of resources and providers.	No awareness of resources or providers, or only weak intensional awareness of types of resources and providers.

Figure 6 Communities Distinguished by Awareness

The key notion here is that the types of virtual cooperative interactions are differentiated on a temporal continuum rather than by discrete categories.

3.3 Awareness Hierarchy of Virtual Cooperative Interactions

At least three types of virtual cooperative community need to be distinguished. A **team** can be treated from a *collective stance* [Gaines94] as a single psychological individual that behaves as a compound role generated by the distributed activities of roles in a number of people. Each resource provider in a team has an *extensional awareness* of their actual resource users, and each resource user has an extensional awareness of the resource and who will provide it. In the tightly-coupled team, each person is usually aware of who will provide a particular resource and often of when they will provide it. In logical terms, this can be termed **extensional awareness** because the specific resource and provider are known, as contrasted to **intensional awareness** in which only the characteristics of suitable resources or providers are known. Both types of awareness are important in the awareness hierarchy of virtual cooperative interactions [Gaines96].

In a **special interest community** resource providers usually do not have such extensional awareness of the resource users, and, if they do, can be regarded as forming teams operating within the community. Instead, resource providers usually have an *intensional awareness* of the resource users in terms of their characteristics as types of user within the community. Resource users in a special interest community may have an extensional awareness of particular resources or resource providers, or an intensional awareness of the types of resource provider likely to provide the resources they require. This asymmetry between providers and users characterizes a special interest community and also leads to differentiation of the community in terms of core members of whom many users are extensionally aware, and sub-communities specializing in particular forms of resource [Gaines96].

In the **community of users at large**, there is little awareness of particular resources or providers and only a general awareness of the rich set of resources is available. Awareness of the characteristics of resources and providers is vague, corresponding to *weak intensional awareness*. These distinctions lead to human factors consequences in terms of the appropriate awareness mechanisms that need to be established for the learning web to function. In a team, resources may be identified precisely by location and name. In a special-interest community, resources may be identified by an intensional indexing scheme that classifies them in terms of the distinctions made by that community. In the community of users at large, resources may be identified both by indexing their content type using a wide variety of taxonomies and by indexing their actual content. These distinctions are summarized in Figure 6.

3.4 Motivations for Participation in the Learning Web

When many individuals participate in a multitude of punctuated discourses (Figure 4), a chain reaction occurs. The accumulative effect generated by this chain of inquiry-response-reaction-response-reaction (and so on) is an evolving topical thread that can become a part of *shared knowledge* among community members. Through automatic archival services such as Hypermail or some individual efforts such as FAQs (Frequently Asked Questioned) and webpages, the shared knowledge persists and grows. An interesting question is: why should individuals contribute to this pro-social process?

Generally, interpersonal behavior can be characterized as a *social exchange* between people, and these social exchanges typically involved both rewards and costs to participants. On balance, an individual will perform those actions which produce the greatest rewards at the least cost [Shaver87]. Therefore according to this cost-benefit calculus, a perceived potential for rewards must exist for individuals to participate and contribute in a cooperative relationship. In contrast with classical social exchange theories [Cook87] (e.g., Kelly and Thibaut's interactional matrix model [Kelly78]) which emphasize dyadic interactions between individuals, **collective social exchange theory** focuses on interactions between individuals and their community. Conceptually, the Internet community is viewed from a *collective stance* [Gaines94] as an entity to 'whom' individual participants exchange information resource with. This collective entity offers participants a valuable informational service (namely, as *a pool of human knowledge* [Berners94]) in exchange for their contributions.

The *norm of reciprocity* is fundamental to social exchange and leads to contributing behavior. The reciprocity norm creates an obligation for repayment that must be satisfied if the interaction is to continue [Shaver87]. However, the way reciprocity operates in collective social exchange is more subtle than in conventional social exchange between individuals. Why should one reciprocate (through contribution) in a situation where social responsibility is relatively *diffused* among community members? One motivation for contributing to the net is for individual to gain positive *self-image* [Jones82]. In this case, an individual has internalized the norm of reciprocity and acts according to the principle of **equity theory**: that is, a person will seek to maintain his ratio of rewards to costs as the same as that of relevant comparison persons [Walster78]. A sense of *guilt* would occur if the individual perceives he has not contributed enough to the community. Hence, he would want to reciprocate fairly.

Another more subtle motivation is that of contribution as an investment in **social power**, that is, the *capacity* of a person or group to affect the behavior of another person or group [Schopler65]. Contributions made by an individual may not only help others but may also help her to gain name recognition from peers. The more one contributes publicly and receives recognition for one's contributions, the more one gains the capacity of power to influence others or the community as a whole. The added weight in recognizing who is first to contribute relevant information also motivates individuals to volunteer information resource more readily. The competition for priority in contribution has been well documented in Merton's studies on the reward system in scientific discovery [Merton73].

The motivational dimension illustrates the importance of *feedback loops* [Losada90] in the reinforcement of virtual cooperative interaction. It provides a coherent explanation for the apparent altruistic behavior of information providers on the web.

3.5 Reinforcement of Virtual Cooperative Interactions

Possible motivations for providing information resource on the web are gaining positive self-image and name recognition. But how does a pro-social behavior initiate and continue? The concern here is with the relationship between the *effect* of an individual's behavior in a *virtual cooperative community* and its impact on the individual's later behavior. This is the basis to **operant conditioning**, the learning process by which behavior is modified by it the consequences of previous similar behavior [Ritzer92]. An individual emits some behavior. The community in which the behavior occurs in tern "acts" back in various ways. The reaction—positive, negative, or neutral— affects the individual's later behavior.

Social learning theory suggests that novel social behavior is first learned through imitation of actions taken by others who act as (social) models [Bandura63]. The reinforcement received by a model serves as information to the person about which behaviors are acceptable and appropriate for the circumstances. Once a novel action has been acquired through imitation, its probability of continuation is depended on the reinforcement it receives. *Vicarious reinforcement*, as well as direct reward or punishment, can play a part in social learning [Shaver87].

On the web, an individual's first successful encounter with a homepage full of relevant information resource provides a positive role model for imitation. Her subsequent positive net-surfing experience will further increase her exposure to other positive models. Once an individual internalizes the web culture which encourages construction of personal homepage (which coincidentally also provides virtual persona for self-image), she will come to view that contribution to the web as a pro-social behavior and act accordingly. The dynamic of *social exchange* then comes into play here, if the costs of putting up information resources (e.g., research papers, hyperlinks to relevant webpages) are relatively low to her (e.g., she has necessary skills and resources), she would contribute to the web. In addition, an original intention to contribute to the web community does not need to exist, she may use her homepage to organize her knowledge resource and contribute to the web community as an after thought (or as a by-product). In this situation, the extensional audience is herself together with a vague sense of intensional awareness of other potential resource users. This form of contribution in punctuated discourse is depicted in Figure 3.

How does reinforcement come into the picture? Frequently, one would encounter some homepages that had been constructed months or years ago without any revisions or new contributions. Their authors have neglected them and ceased to contribute. Once a novel behavior has been acquired, it needs to have *intermittent, positive reinforcements* to sustain the behavior [Bandura63]. In order for reinforcement to take place, there must exist a feedback loop like the one depicted in Figure 4. The round-trip cycle (t1+t2+t3+t4) of virtual cooperative interaction provides an individual the necessary awareness of the *effectiveness of investment in social power* which is crucial to reinforcing the behavior and leading to similar future actions.

An observable measurement of the effectiveness of social power on the web is the relative popularity of a website. The popularity of a homepage can be inferred from recognition earned by its visitor frequency counter, commentaries in its public guest-book, awards given by reviewers of popular websites, and the number of other webpages linked to the page, etc. These gauges of popularity (which measure the relative power for social influence) provide direct reinforcements (can be either positive or negative) to an information provider. They also offer indirect, vicarious reinforcements to other information providers by providing social models for comparisons.

4. SUMMARY AND CONCLUSION

The support of virtual collaborative interaction on the Internet has developed pragmatically without deep conceptual models. Awareness-support tools such as Yahoo and Lycos have been developed because of a perceived need to ameliorate information overload through better indexing tools. However, the indices generated by these tools also contribute to the social exchange mechanisms that motivate participation in Internet communities, and the design of such tools has to recognize their multiple roles.

	Groupware	**Socioware**
Awareness	strong mutual extensional	weak mutual intensional
Time-Cycle of Interaction	short to medium (seconds to days)	medium to long (days to years)
Motivation for Cooperation	individual social exchange	collective social exchange
Power Relations	well-defined roles as part of team definition	emergent roles from investment in social power capacity

Figure 7 Comparisons between Groupware and Socioware

The early development of the conceptual model described in this paper led to the authors' realization that *chronological awareness* was not well-supported by existing web tools [Chen96]. CHRONO[1] is a tool resulting from this analysis. We noted that one dimension of awareness management is keeping track of a site where relevant information has been available in the past. CHRONO generates a "what's new" page for a site automatically by indexing the site in reverse chronological order so that a visitor may readily note changes that have occurred since his or her last visit. *WebWatch* [Specter95], *Katipo* [Newberry95], and *URL-Minder* [NetMind95] are other chronological awareness tools that track changes in specified documents. The key question to ask in developing new awareness support tools is "what is the starting point for the person seeking information? i.e., the existing information that is the basis for the search" A support tool is then one that takes that existing information and uses it to present further information that is likely to be relevant. Such information may include relevant concepts, text, existing documents, people, sites, list servers, news groups, and so on.

The conceptual model presented in the article implies that for successful maintenance of continual virtual cooperative interactions in the learning web, the following criteria must exist:

- establishment of resource awareness for initial encounter
- establishment of mutual awareness as a feedback loop for continual virtual cooperative interactions
- compatibility between the expected and the actual time-cycles of virtual cooperative interactions
- properly situated expectation of fairness in terms of collective social exchange
- accumulation of positive feedback for reinforcements in virtual cooperative interactions

The current model can also be used to categorize computer-mediated environments roughly into groupware and socioware (Figure 7). It also identifies the types of systems that are needed to expedite collaborative activities. It focuses on participants' motivations and power relationship which determine their social roles, goals, expectations in the learning web.

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[1] For more information on CHRONO and others awareness tools: see: http://ksi.cpsc.ucalgary.ca:8008/cgi-bin/release?cmt7

The article contributes to CSCW research by drawing attention to their added significance in socioware like the web where social and organizational structures are fluid and less well-defined. The conceptual model for virtual cooperative interactions in the learning web expands the scope of groupware research. It provides a framework encompassing all forms of CSCW from teams through organizational workgroups to diffused, evolving communities. Modeling and supporting virtual cooperative interactions on the Internet are important new challenges for distributed learning research.

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Building Web Collaborative Learning Environment by Active Database

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Abstract: Existing Computer Assisted Learning (CAL) systems use computer programs to simulate a teacher in individual learning. However, regardless of how good the CAL system is, a student can hopefully interact with learning companions and teachers. Owing to the popularity and easy access of the computer network and communication tools, network facilities can be incorporated into a CAL system and make it a Computer-Supported Collaborative Learning (CSCL) system. To attain a good learning result, a CSCL system must be able to (1) arrange a group learning model, (2) constraint and notify the students to learn according to the arranged model, and (3) have query facilities which provide the teacher with information regarding what a student has done and learned, and what a student should do. The rule based system that is conventionally used can not sufficiently provide those required functions. In this paper, we account for why and how to use an active database system can achieve those goals.

Introduction

Existing Computer Assisted Learning (CAL) systems use computer programs to simulate a teacher in individual learning. However, regardless of how good the CAL system is, a student can hopefully interact with learning companions and teachers. Owing to the popularity and easy access of the computer network and associated communication tools, network facilities can be incorporated into a CAL system and make it a CSCL system. Students in a CSCL system can learn by discussing, asking questions, or collaborating through the computer network. Wells (1992) summarizes feasible learning activities through conventional network tools for distance education. However, to achieve a good learning result, a teacher should carefully arrange the group learning activities and understand the status of students well.

Collaborative learning [Bricker *et al.*, 1995; Monaghan & Clement, 1995] styles are often used in a conventional classroom. The students can be divided into groups. The members of a group can be assigned with different roles. Tasks (homework or exercises) can be divided into different sub tasks that can be assigned to different roles in a group to tackle. Concepts can also be discussed from different perspectives. A role in a group should present his conception according to his/her assigned perspective. The learning effect can be improved because students can observe and learn things from different views. Besides, the students can be motivated through the group and peer pressure. The students in a group are more willing to cooperate, exchange ideas, and share experiences in order to get a good score for their group. However, it would be of great burden for the teachers to construct collaborative learning activities by existing communication tools, such as Internet Relay Chat (IRC), World Wide Web (WWW) and so on. The teacher should participate in the discussion and do the tasks for assigning roles, notifying students, enforce schedules, regulating students for what he/she should do, and accumulating information to understand the status of students.

The basic facilities for supporting a collaborative learning activity are regulations, agenda, and transcript. Most existing CSCL systems construct learning activities by using existing network tools. For instance, a teacher wanting to construct a collaborative learning activity on the computer network must implement the mechanism of regulation, agenda, and transcript on the computer network. Otherwise, the teacher should manually handle these tasks by himself/herself. Consequently, the difficulties encountered in constructing collaborative learning activities on current CSCL systems include the following.

First, a teacher has difficulty in constructing a collaborative learning activity because most network tools do not support collaborative style of working. The teacher must arrange the style of collaborative work and define what a group member can do. For instance, a teacher issues a homework that should be a collaborative task. This homework is divided into sub parts. Each part is assigned to a particular group member. Each group has a leader who should combine the four parts into a complete solution. For each part, the assigned member can present his idea and solution and other members can only provide suggestions and arguments. However, the group leader can modify the sub part solution. Group members can only view the results and discussion of their group, unless they hand out the results. These issues are referred to *specification and regulation* problem.

Second, a teacher must maintain the progress of an activity because network tools can not automate the agenda of an activity. Take the example in the above group homework. The teacher can define a schedule for each group, for each sub part, and the final results. Besides, if other members have an opinion regarding a subpart idea or solution, the assigned in charge member must respond in 24 hours. The issue is called *automating schedule* problem.

Third, a teacher wanting to query what is going on in collaborative learning activities must put tremendous effort into finding the required information in an amount of data generated. The historical data of a collaborative learning activity are called "complete *transcript* of the interactions" as [Davie, 1987] proposed. Consequently, a teacher will be bothered by the problem of information overloaded [Hiltz & Turoff, 1985] because he/she must monitor the progress of activities. Furthermore, a teacher can not dynamically prepare a course without the mechanism of querying the transcripts, which implies students' learning history. For instance, the teacher wanting to know the member who delays a group result. Another example is the teacher wanting to know the complete learning history of a student. We call this issue as *recording and querying transcript* problem.

This paper attempts not only to resolve the above mentioned problems of CSCL systems from a database perspective, but also to identify the required functionality for constructing collaborative learning activities of CSCL environment. The initial motivation of using a database system originates from considering the *transcript recording and querying* problem. Survey of the database technology reveals that the active database may solve the *specification and regulation* and *automating agenda* problems. To resolve the *specification and regulation* problem, the active database [Kim, 1995] is applied to construct a collaborative learning activity, which is independent of employed network tools. To resolve the *automating agenda* problem, the agenda of an activity can be automated by integrating temporal issues and an active database. To resolve the *transcript recording and querying* problem, the query powers of the database can solve the problem of information overloaded and make it feasible to query the transcript of an activity. Herein, the advanced technology (active database) and theory (temporal logic) is employed to draft the infrastructure of CSCL systems. To account for the above mentioned problems, an example describes the tasks to be performed. Next, our methodology is described to address the issues. Applying the methodology can also construct other collaborative learning activities.

A Collaborative Homework Example

A motivating example is presented herein to elucidate the difficulties of constructing collaborative learning activities. The collaborative learning activity uses a discussion model called IBIS [Kunz & Rittel, 1970; Conklin & Begeman, 1989], that is *Issue Based Information System*. The IBIS model starts with an issue. Many positions are then proposed to resolve the issue. Many arguments are available, which may support or object to a position. A position may derive a new issue, which may generalize, specialize, or replace the previous issue. The IBIS model is effective in collaboratively resolving a designing problem.

We assume that a teacher would construct a collaborative homework activity by using IBIS model. The teacher wants students to decompose a homework into three components. Students are subsequently divided into three groups and each group is assigned to discuss one of three components with IBIS model. Moreover, there must be a moderator in each group to summarize a solution in time. A student can propose a position and defend for his/her group; however, he/she can only propose the argument for the other group. A discussion for combination is held with IBIS model finally. Sub solutions of three components must be refined if some problems are found in the discussion for combination. A final solution is summarized after the discussion for combination. [Fig. 1] shows the collaborative homework with IBIS model.

The teacher immediately faces some requirements. First, students must be divided into three groups and the teacher desires that each group has a user assigned as a moderator, who can determine whether to derive a new issue and summarize a solution in time. Defining legal behavior for a different user is necessary. Second, a

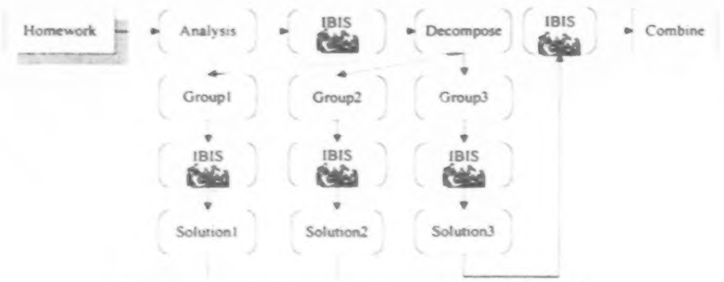

Figure 1: A collaborative homework with IBIS model.

moderator should notify the owner of a position to defend his/her position when other members argue the position. An active mechanism is required to automatically notify releasing the moderator's burden. Third, the teacher may want to identify the most argumentative position or the most active student from the records of discussion. A teacher requires an effective approach to query the transcript of an collaborative learning activity.

The following specifications illustrate how to construct the collaborative homework from a database perspective. To depict the enhancement, we used the informal representation: WHEN the <event> is detected and IF the <condition> is satisfied, THEN the corresponding <action> is performed. The events relevant for an activity include: database events (insertion, deletion, modification, retrieval), and temporal events (at a given time, or at any time after a specific event), such as "deadline of a homework." Conditions mean the expected results from a database query. Actions imply sequences of commands that can be database operation or external (user defined) processes, such as the notification.

Client

```
  Role: student
    Capability:
        propose a position to an issue in his/her group.
        propose an argument to a position in any group.
        request the moderator to derive a new issue.
        answer objects-to arguments of proposed position.
    Constraint:
        When requesting a teacher to derive a new issue from a position
                if the student did not propose a position
                then deny and notify the student "propose your position!"
  Role: moderator
    Capability:
        determine the initial issue.
        determine whether to derive a new issue.
    Constraint:
        When a student requests to derive a new issue from a position
                if the request is not answered currently
                then the request will be answered in the future eventually.
```

Role-based activity server

```
        check the identification, including group and role, of a client
        retrieve capabilities and constraints of the client from active database
        receive the action from active database to notify the client
  IBIS model
        When adding a new node
                then the type of node is one of {issue, position, argument}
        When creating a link
                then the type of link is one of {supports, objects-to, responds-to, questions is-
                  suggested-by, generalizes, specializes, replaces}
        When adding a child node to an issue
                if the type of link is responds-to
                then the type of the child node is position
        ...
```

Active notification:

When a question to a moderator for deriving a new issue is not answered
    if the question is not answered more than two days
    then immediately notify the moderator to make a decision.
When an objects-to argument of a position is not answered
    if the argument is not answered more than two days
    then notify the owner of the position to answer the argument.
...

Reasons for Applying an Active Database System to Distance CAL Systems

A large number of tools, e.g. Internet Relay Chat, World-Wide Web [Berners-Lee *et al.*, 1994], mail, on Internet provide various communication styles. The advantages come with those computer network communication tools including multimedia communication, asynchronous learning and discussion, on-line learning materials, social relationships, etc. Meanwhile, the flexible and distributive characteristics make some requirements of CSCL feasible on the computer network. Although those advantages could adhere to some requirements of CSCL, CSCL systems also involve some tasks that can not be implemented only by the network tools, e.g. controlling access to information repositories, scheduling, inferring, and notification. Integrating network tools with the advanced database technology can provide some required mechanisms that are difficult to be implemented merely by the network tools. For instance, the active database can satisfy the requirements of the collaborative homework example, including to define the regulation and agenda of an activity, to automatically handle the agenda of an activity, and to provide a mechanism for querying learning history.

- Constructing activity -- It refers to constructing the regulations of group interaction, among which includes the roles of users, their interrelationships, and notification. For instance,

  a moderator can derive a new issue and summarize a solution; students only propose positions in his/her own group; (1)
  system must construct the relationships of group. (2)

- Automating agenda -- Whether an interested event occurs and a response to it made must be monitored by a procedure automatically. For instance,

  the system should automatically notify a moderator who did not summarize a solution after the deadline. (3)

- Querying transcript -- A teacher can manage the activity through querying the transcript of an activity. For instance,

  list the students who often propose argument to other groups.

Most of the current CSCL environments did not consider how to construct a learning activity with the supports of a database. Consequently, aforementioned requirements, that can be easily achieved by a database, can still not be satisfied in the existing CSCL systems.

Active Database Support for Distance CAL Systems

An active database monitors situations of interest, and when they occur, triggers an appropriate response in a timely manner [Kim, 1995]. There are three components in an active database. First, an event monitoring subsystem monitors situations of interest. Second, a set of rules can be triggered by a series of events. Third, an execution model promises the temporal aspect of a response. Active database can satisfy the aforementioned requirements because an active database can attain aforementioned goals by the three components of an active database:

Constructing activity

Monitoring behaviors of a role is essential in a CSCL system. To effectively supervise users' behaviors, a CSCL system must construct users' interrelationships and attach constraints to communication behaviors.

- *Assign Role* includes specifying the capabilities and constraints of a user. In (1), users can be expressed as

  Teacher's capabilities: derive a new issue and summarize a solution (1a)
  Student's constraints: propose positions in his/her own group (1b)

- *Determine agenda* refers to the workflow of an activity. For instance, a moderator should make a summary after a conference activity. (2) can be refined as:

  Rule1 for moderator: summarize a solution when deadline is due (2a)

Automating agenda

This component includes two mechanisms: First, an active mechanism for checking conditions determines whether the event occurs. Second, a language specifies the responding procedure with temporal issues.

- *Detect event* -- Based on the determined agenda, an active mechanism monitors various events, e.g. the data access, and database update. The actions of an agenda specification will be triggered when an event satisfies the conditions of an agenda specification. In (3), it refers to

  System should automatically do something when Rule1 is triggered. (3a)

- *Activate action* -- An action specifies what to do when the event is triggered. The action specifications are associated with roles or activities. For instance, the specification in (3) is

  Notify the moderator to summarize a solution (3b)

Furthermore, an active database system is a superset of a traditional database system, that can naturally provide the power to query the transcript of an activity by query language, e.g., SQL. Most importantly, active database systems can provide functionality to support the requirements of a collaborative learning activity. First, active database systems can provide the *event-based interaction*, which servers as an inference engine matching the condition parts of agenda rules (2a). Second, an active database system can attach a role of some *collaborative constraints*, which maintain the relationships of users' roles. Third, the execution model can integrate learning activity *with temporal triggers*, which guarantee the workflow of an activity. To sum up, the approach integrates the model of active database with temporal issues. Consequently an end user, teacher, can construct a collaborative learning activity with a formal foundation.

Procedures for Using an Active Database in Distance CAL Systems

Some assumptions abound regarding the procedures for using an active database to construct collaborative learning activity in CSCL systems. First, the regulations of a collaborative learning activity are based upon the realistic assumption that users participating in a collaborative learning activity are not autonomous. Detecting whether a role's tasks were completed is subsequently necessary because of the assumption. Second, the collaborative learning activity must be accessible in a distance. Consequently, there must be a server that users can connect from any place. Third, users should be able to communicate and exchange data with the server. Consequently, there must be a user client program to interact with the user and communicate with the server. In other words, the collaborative learning activity consists of *clients, role-based activity server,* and *active database* on above assumptions.

The improvements originate from the server with the following enhancements. (1)*Identify the role of a client.* A client(user) can play many roles, and a set of clients(users) may only play a role. Identifying the role of a client is so important that the server can obtain capabilities and constraints associated with the role from active database. (2)*Endow capabilities of a role.* The capability of a client is defined according to its role in an activity. These capabilities originate from the previous specification of a role in the active database. The capabilities specify all the possible behavior of a role. (3)*Maintain constraints of a role.* The constraints of a role cover the capabilities with a temporal or non-temporal boundary of any particular role. Only under the satisfaction of these set of constraints can the client(user) undertake a given role. (4)*Autonomous notification to a role.* Notifying a role of some situations is useful for the server. The notification is made active by the specification of actions in active database. Autonomous notification is useful to maintain a long-duration activity because there is always someone forget to do something on schedule.

The collaborative homework example shows how to enhance the client-server architecture with roles and activity. Furthermore, that informal representation can be translate into the following formal syntax in an active database. A situation constraint, called *ECA rule* in the literature of active database, is defined as a sentence of the form:

define rule rule-name **on** <event> **if** <condition> **then** <action>

In these <...> items, *First-Order Temporal Logic* [Abadi & Manna, 1990] is applied to handle the temporal issues and specify the temporal constraints of an activity. FOTL has been introduced in the areas of information system design, and specification. Because the logical system used in above example is linear and discrete with respect to the model of time, only two future temporal operators of FOTL are required:

Nexttime A means "A is true in the next state" and A Until B means "A is true until B is true";

where A and B are formulas. Other temporal operators, such as Always, Eventually, can be expressed with the basic operators.

Now move towards the collaborative homework example. The first two rules for active notification must query the transcript of the IBIS discussion activity with a temporal issue. If the query results satisfy the expected conditions, the system will detect the temporal condition. When the temporal condition is satisfied, the action is triggered. To illustrate how to translate the informal representation into a formal syntax in an active database, the first active notification can be represented as the following ECA rules:

```
IBIS-Data(Node, Node_type, Date, Link, Link_type, ...)
define rule AutoNotifyTeacher
on (select IBIS_Data.Node
    from IBIS_Data
    where Node_type = ISSUE and
            Link_type = NULL)
if not(true Until (IBIS_Data.Date - Date > 2))
then notify teacher
```

Conclusion

In this paper, we have (1) analysed the requirements to construct collaborative learning activities for CSCL systems, (2) depicted why the active database can satisfy the requirements by a collaborative homework example, and (3) proposed the procedures for using an active database to construct collaborative learning activity in CSCL systems. Our results indicate the requirements to construct collaborative learning activity including constructing activity, automating agenda, and querying transcripts of an learning activity. The active database has distinctive advantages and additional facilities in contrast to other techniques for developing CSCL systems. We apply additional facilities, i.e. rule base, event monitor, and execution model, to the collaborative homework example and obtain the distinctive advantages, i.e. event-based interaction, defining regulation as rules, and temporal trigger. Furthermore, we indicate the requiring software architecture and procedures for implementation. The procedures demonstrate how the active database technology can be used to construct an activity and automatically execute the agenda of a collaborative learning activity in the required software architectures. Finally, we map the specification to the notion used in the discipline of active database to expound the feasibility of the methodology.

Most importantly, a perspective is provided herein that will benefit both CAL and Database communities. For the CAL communities, the proposed methodology for a CSCL system is based on considering the available database technology and requirements of CSCL systems. For the Database communities, new requirements can be realised, including the requiring functions, relationships among the functions, and interactions with users, when using a database to support CSCL systems. In the long-run, we believe that a synthesis of the disparate technologies will contribute to construct any CSCL system.

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GLS: Global Learning Society

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Abstract: We propose the *Global Learning Society* model of social learning. This model is based on the society structure in organizational behavior.. GLS model is composed of three layers: *Society Kernel*, *Learning Environment* and outside users. *Society Kernel* utilizes Society Server and Group Server to facilitate society management, such as user registration and login, user activity recording and activity server maintenance. *Learning Environment* provides users with various society learning activities, including individual and group learning activities. All these components are integrated through four communication protocols: user registration, group creation/deletion, member join/leave and data transfer. To prove the idea of the GLS model, we have implemented a demonstration system that runs on the Internet. This system uses state-of-the-art techniques of WWW (World-Wide Web).

1. Introduction

The use of computers has brought CAI (Computer-Assisted Instruction) technology into traditional education. The development of networking, especially Internet and WWW (World-Wide Web), opens a new era of *distance education*. Since 1980s, many scholars have made tremendous efforts to study new education strategies that utilizes computer networks. This includes cooperative or collaborative learning systems [Heh *et al.*, 1996], competitive learning system [Chan & Lai, 1995], reciprocal tutoring system [Chan *et al.*, 1996]. All these learning styles fall into one integrated framework called *social learning system*. [Chan, 1996]

A social learning system is defined as a learning system that runs on a computer network, where real users and computer simulated agents can work together. There are two categories of such systems: centralized social systems and distributed social systems. In *centralized social systems*, such as Integration-Kid [Chan, 1991] and People Power [Dillenbourg & Self, 1992], users connect to one specific computer and usually work with simulated agents. *Distributed social systems*, on the other hand, focus on the issue of supporting a group of persons, each in a different location. These persons learn together through networking.

One social learning structure, called SPOT (Structure, Protocols, Outcomes and Techniques), was proposed to explain the constitution of social learning systems. [Chan 1996] In SPOT, S (Structure) represents system configuration and agent types, P (Protocol) indicates the learning styles, such as collaboration and competition, O (Outcomes) is the learning effectiveness and evaluation, and T (Technique) includes related implementation techniques, such as dialog modeling and networking. The SPOT model describes almost all the components used in social learning systems. However, it is not well integrated.

From the viewpoint of sociology, a social learning system is a society built on computer network. Also, studies in organizational behavior [Robbins, 1983] suggests that members in a society participate in some specific group or individual activities and then present their group or personal behavior. As is the case with social learning systems, members (users or agents) in a learning society would be engaged in some group or individual learning activities to attain learning effectiveness. In terms of the SPOT model, a learning society introduces the society structure (S) and analyzes the learning activities (protocols) and its efficiency (O). The entire (virtual) society is built on the Internet (T), which makes the idea of a global learning society possible.

Following the SPOT model of social learning systems, we propose a *global learning society*, abbreviated as GLS. In Section 2, a three-layered architecture of GLS model: Society Kernel, Learning Environment and Outside Users, is described. This architecture is derived from the sociology structure in organizational behavior. Section 3 analyzes all the functions of components in GLS model and sets up the communication protocols among these components. Finally, this model is implemented on the Internet. The implementation makes use of state-of-the-art techniques of WWW (World-Wide Web) to prove the idea of GLS model in Section 4. Section 5 gives a conclusion.

2. Basic Model of Global Learning Society

A *global learning society* (GLS) is a virtual society built on the Internet. It allows the users to perform learning activities through networking. Users can participate in more than one society for different courses, and different societies can be set up for different courses in various ways. A GLS can be investigated from two perspectives:

- From the viewpoint of a system, users can take part in several learning activities, through which they interact with each other and the courseware. Meanwhile, these activities are managed by GLS, which provides an integrated Internet environment for such learning. Therefore, we have the following hierarchy: system, activities (with user interactions) and users.
- From the viewpoint of a society, a user chooses one activity to become a member of this activity. All users participating a specific activity naturally form a learning group. This matches the society structure in organizational behavior: society, group and member.

It is from these two perspectives that we develop the basic GLS model as a three-layered structure: Society Kernel, Learning Environment and Outside User (Figure 1). *Society Kernel* facilitates some centralized society management mechanisms, such as registration tool, user record and activity management, and group management. *Learning Environment* provides various social learning activities, including individual learning activities and group learning activities. These activities in the environment implement different computer-assisted learning methods for traditional education. As a result, users in different places can choose different learning styles in Learning Environment to meet their own needs.

Each user in the GLS model has a unique name. Users can be managers, teachers, students, guests, or just software agents, and are divided into three categories by their roles:

- System Manager: A system manager is one who is in charge of all system functions in the Society Kernel.
- General User: A general user can be a teacher, a student, or a guest, who carries out the designated learning activity in Learning Environment.
- Software Agents: A software agent acts as an alternative learning peer when a user cannot find suitable partners in a group activity. Software agents are also called Virtual Learning Companions (VLC) [Chan and Baskin, 1988].

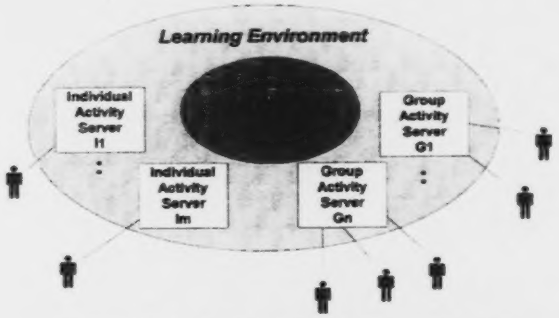

Figure 1: Basic Model of Global Learning Society

Users performing the same learning activity form a learning group, called an *activity group*. These users are then the members of this *group activity*. A group with just student members (maybe peers or tutor/tutee) form a group learning environment. In a more sophisticated design, learning may be either cooperative, collaborative, or competitive. Group learning activities can be classified into two categories according to the styles of user interactions:

- Synchronous Activities: all members are on-line at the same time, and the interactions are immediate. Examples of this include RTS [Chan and Chou, 1995] and Distributed West [Chan *et al.*, 1992].
- Asynchronous Activities: the members need not be present (before their computers) at the same time,

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and user interactions are not immediate. This kind of interactions are very similar to those of the BBS (Blackboard Bulletin System).

A group with both teachers and students as its members can undergo distance teaching activity, whether the teaching style is synchronous or asynchronous. Some activities need just one user (usually a student, such as homework delivery and courseware reading) as its member. These activities need no group and are called *individual activities*.

3. Analysis of Global Learning Society

We give a more detailed analysis of the basic GLS model in this section. Figure 2 depicts a layered architecture of the basic GLS model. In this architecture, the ordering of the layers, from the inside out, is Society Kernel, Learning Environment (including its activities) and users. There are several databases in Society Kernel and many protocols, denoted as P1-P4, between different modules. Two important components are included in Society Kernel: Society Server and Group Server. *Society Server* is the core of GLS, which takes charge of all the operations in the society. It also communicates with other societies to exchange user activity information. The operations can be divided into three categories:

- Initialization: Society Server should be executed first as the whole society starts.
- User Interactions: Society Server has a list of all users. It delivers suitable Activity Clients to the requesting users according to different user privileges,. At the same time, it receives user commands and does further processing. All these actions will be recorded in some database.
- Group Server Invocation: The users' requests are transmitted to Group Server, and Society Server is always ready to respond.

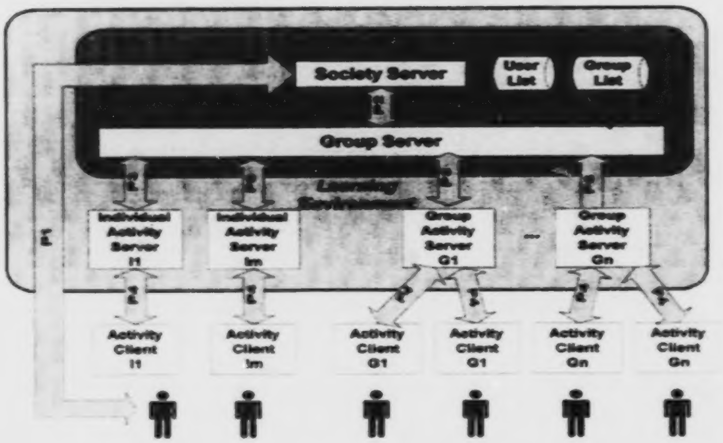

Figure 2: Analysis Model of Global Learning Society

The other important component in Society Kernel is *Group Server*. It manages all activities, including those of the individuals and those of the groups. Since each activity adopts client/server model in its implementation, the addition of Group Server makes a standard, three-layered groupware structure: group server, server and client. [Liang *et al.*, 1994] The operations of Group Server can be divided into three categories:

- Initialization: Group Server has to be executed together with Society Server as the society is initialized.
- Group Management: When Group Server received the transferred user-commands from Society Server, it has to process suitable group operations for the requesting user. These group operations may be the creation or deletion of a group, or some other operations to be executed in designated Activity Server.
- Activity Server Invocation: Actual group operations are put into practices in Activity Server. All user requests for the group will eventually be transferred to some designated Activity Server, and the action results will be kept in records.

In addition to the two databases (User List and Group List) shown in Figure 2, Society Kernel may also

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possess some logfiles. These logfiles can be used to record the actions among user-society and society-group. Logfiles are not a main component of the basic GLS model and hence are not shown in Figure 2.

No matter how simple or fantastic model a Society Kernel is, it is only a skeleton of our GLS. The ultimate user-group interactions would happen in the Activity Server / Activity Client pair. As mentioned above, the activities that the users take part in are either group activities or individual activities. Here, the so-called *Individual Activities* are not that a user can work by himself or herself in the world, but that he or she can process some learning activities through the computer network. Activities of this sort include courseware reading, homework delivery and exercise practicing. In GLS, Individual Activities are implemented using the client/server model; that is, users use certain Activity Clients (delivered by Society Kernel) to communicate with Activity Servers in order to perform the needed activities. Users can also participate in some groups and then perform some group actions.

Basically, a user can create a new group, join an existent group, leave a group or delete a group (if he or she created it). All these constitute the basic group actions emitted by a user to Society Kernel. As for actions of special groups, Society Kernel only transfers the user command to the group (Activity Server) and let the Activity Server respond to the command. In practice, both synchronous and asynchronous group activities have the following communication requirements:

- Synchronous Group Activities: These activities require that all Activity Clients be present in front of their computers. The clients communicate through networking. If the communication bandwidth allows, they can have real-time information exchange. In practice, however, the real-time media had better be text or command. If multimedia communication such as audio or video conferencing is to be used, large bandwidth is a must.
- Asynchronous Group Activities: In addition to the bandwidth constraint, one other disadvantage of synchronous group activities is the requirement of simultaneous presence of all users. Even if this is not impossible, the requirement still imposes some inconvenience on the part of the users. This is why asynchronous group activities are more attractive in cases like BBS and WWW. To engage in this kind of activities, users need not be present at the same time. They still take part in some activities for a common goal within some specific time framework, and are still treated as a group.

No matter how the components of GLS, including Society Server, Group Server, Activity Server and Client, are designed, the only element that can integrate all these components into one coherent framework is the protocols. As shown in Figure 2, there are four different kinds of protocols in GLS: P1, P2, P3 and P4. They denote, respectively, the interactions between User (Activity Client) and Society Client, those between Society Server and Group Server, those between Group Server and Activity Server, and those between Activity Server and Activity Client.

P1 (User Registration Protocol)	Action	Course Name	Class Number	Activity Type	User Name			
P2 (Group Creation/ Deletion Protocol)	Action	Course Name	Class Number	Activity Type	Group Name	User Name		
P3 (Member Join/ Leave Protocol)	Action	Course Name	Class Number	Activity Type	Group Name	User Name		
P4 (Data Transfer Protocol)	Packet Type	Destination School	Course Name	Activity Type	Destination File	Access Type	User Name	Data

Figure 3: Communication Protocols in GLS Model

Figure 3 shows the formats of all four protocols. Action can be group creation, deletion, join, or leaving. Destination School is the server name of the school. And Access Type may be read or write. General group and member actions in GLS can be accomplished through the interactions of related protocols, such as

- Creation or Deletion of a Group: A user emits *P1 (User Registration Protocol)* to Society Server, Society Server notifies Group Server through *P2 (Group Creation/Deletion Protocol)*, then Group Server creates or deletes the group and activates the corresponding Activity Server by *P3 (Member Join/Leave Protocol)*.
- Join or Leave of a Member to or from a Group: A user tells Society Server the request (P1), Society Server then tells Group Server (by P2), Group Server checks the existence of the group and notifies the new member to the corresponding Activity Server (by P3). Then the user (Activity Client) can directly communicate with the Activity Server through *P4 (Data Transfer Protocol)*.

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The protocols glue all GLS components together and makes the GLS Model work efficiently.

4. WWW Implementation of GLS

As network technology evolves, the realm of Internet grows ever larger. This is especially true with the hyperlink capability of WWW, which makes the whole world a connected communication net. Therefore, an example system is established on WWW to demonstrate the functions of GLS model. In this example system, a virtual school is treated as a society, with courses delivered in different learning styles to various learning groups. As Figure 4 shown, this example system contains Society Kernel, Homework Delivery Server, Learning Café Server, SoftLab Server and Data Mining Server.

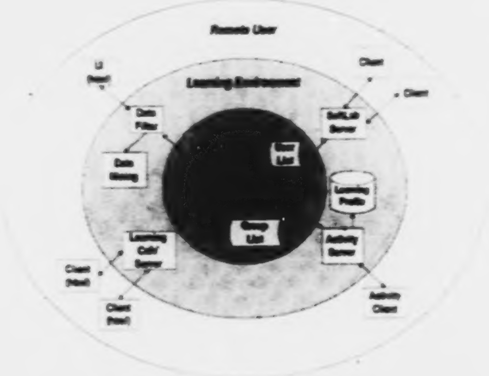

Figure 4: An Example System of Global Learning Society

In Figure 4, each component of the GLS model is built as either a Java applet, a CGI (Common Gateway Interface) program, or a system daemon. The communication protocols P1-P4 may be implemented in TCP/IP socket or IPC (Inter Process Call).

As mentioned, Society Kernel has two major components: Society Server and Group Server that are built as system daemons that run on the server side. The program structure of Society Server includes:

- User maintenance module: This module maintains a user list and controls which privilege a user can possess when joining a group.
- User activity recording module: As a user joins a group, this module records the group name, joining time and the actions the user takes.
- Communication module: This module provides communication channels with protocols P1 and P2.
- Registration module: This module allows a user to register in GLS.

The program modules of Group Server are:

- Activity Server maintenance module: This module keeps track of all Activity Servers, including the starting and stopping activities of these servers.
- Communication module: This module maintains two protocols: P2 and P3.
- Record transferring module: As a user enters a group, all his or her data records should be transferred to the corresponding Activity Server. Likewise, some actions of the users are passed on to Society Server.

As mentioned, each Activity Server in GLS model implements an activity, including individual activity, synchronous group activity and asynchronous group activity. In the example system, three Activities Servers/Clients are built to demonstrate the functions of each activity. As Figure 4 indicated, Homework Delivery is an individual activity, through which a student can send his or her homework to the instructor. Figure 5 shows one usage of our system. Figure 6 displays an asynchronous group activity, called Learning Café, in which different users can learn cooperatively or competitively in different (or the same) learning units. The different join/leave time makes this activity asynchronous. Another learning activity is SoftLab [Chung *et al.*, 1997], in which different users can cooperate in performing a virtual experiment.

There is yet another activity, called Data Mining, which is used for data collection and system evaluation (called Outcome in SPOT structure). It extracts user activity records to generate some estimate data, and tries to evaluate system performance or users' learning effectiveness. This way, we not only can improve our system to

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fit users' requirements, but also can give learners some suggestions regarding learning activities.

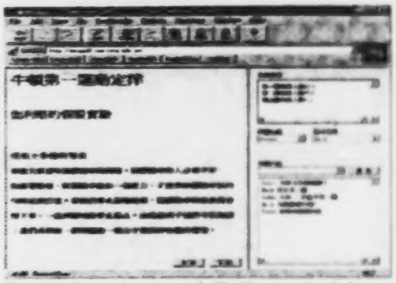

Figure 5: Homework Delivery Activity

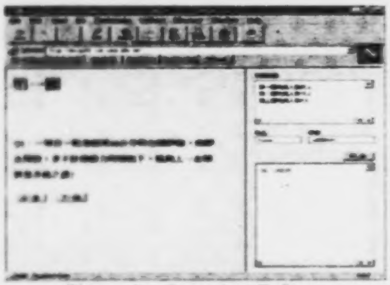

Figure 6: Learning Café

5. Conclusion

Combining the S (Structure), P (Protocol), O (Outcome), T (Technique) components in social learning systems, a basic model of GLS (global learning society) is proposed in this paper. From the viewpoint of organizational behavior, GLS model possesses a three-layered architecture: Society Kernel, Learning Environment and Remote Users. Society Kernel includes Society Server and Group Server. As users invoke some individual or group learning activities, Group Server would activate certain Activity Servers to serve the users. Then the users use Activity Clients to communicate with Activity Server in client/server style. All the functions of components are investigated and their in-between protocols P1, P2, P3 and P4 are analyzed to get an integrated GLS model. This model is implemented on WWW to confirm the feasibility and some practical considerations are listed.

In the near future, a more integrated system will be provided on our WWW site. And then some real tutoring / learning activities will be held in actual classes. Besides the three social learning components: S (GLS basic model), P (P1-P4 protocols) and T (WWW implementation), the fourth component O (Outcome, evaluation and learning efficiency) should be taken into consideration as well. This brings the issue of Data Mining into the picture.

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Online Teaching: The Delights and Dangers of Pseudonymity

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Abstract: This paper describes our experience as teachers (and learners) in cyberspace. An evaluation of the literature on computer-mediated communication (CMC) is presented and the two major theoretical positions, the filtered-cues and social information processing perspectives, are explicated. Although generally considered divergent positions, it is argued here that they are complementary, both being required to adequately describe the potential of CMC for teaching and learning. With a desire to create enough relational connection to establish a "learning community", but still play with notions of anonymity online, we encouraged students in our subject to explore pseudonymity, adopting and playing with an alias. The subject is described together with our observations of the benefits and disadvantages of pseudonymity for education.

In her book Life on the Screen, Sherry Turkle [1996] describes the concept of *depaysement*. Appropriated from anthropology, depaysement, meaning literally to "decountrify" oneself, is defined as the experience of (re)seeing. "One leaves one's own culture to face something unfamiliar, and upon returning home it has become strange - and can be seen with fresh eyes". (p.218) Cyberspace is rich with opportunities for depaysement: we can experiment with how it feels to be the opposite sex or sexless, we can change our ethnicity or the colour of our skin, we can develop relationships with people we would never meet face-to-face (FTF); all of which enable us to experience a different perspective from which to (re)view the self and real life (RL) constructs. This potential of cyberspace is at the heart of our teaching online. Our aim is to help students, through their work in cyberspace, experience the challenging shift in perspective that is depaysement; our aim is to encourage them to (re)see the familiar and develop a critical appreciation of the potential of technologies.

Teaching in cyberspace has also given us a chance to (re)view the familiar in our educational practice, thereby using our life online to inform our FTF teaching. Several writers have already begun to note that debates about technologies are leading to a (re)viewing of pedagogy [Atkins, 1991; Spender, 1995]. Our paper therefore adds to this small, but growing body of (re)vision. Our focus is the use of the alias in online education. In a medium associated with anonymity, we explore the impact of enforced pseudonymity, that is the use of an alias, on teaching and learning.

Online Anonymity

An increasing body of work on computer-mediated communication (CMC) has grown out of our own discipline, social psychology. This literature was our starting point when we first began thinking about teaching a subject in cyberspace. Within this literature there exist two distinct theoretical positions, the filtered-cues approach and the social information processing position. Both theories offer potential insights into the use of CMC for teaching and learning.

Early work on CMC, based on what was known as the filtered-cues position, described the medium as one bereft of *social context cues* [Sproull & Kiesler, 1986]. These cues define the social nature of the situation and the status of those present and include aspects of the physical environment and body language, as well as paraverbal characteristics such as the volume, emphasis, and rate of speech. With such cues largely filtered out, CMC has been described as a lean medium that is relatively anonymous.

Although most of this early work took place in the organisational context, some research from educational settings supports the filtered-cues perspective. The benefits of online anonymity for teaching and learning have included increased equity [Collins & Berge, 1995; McComb, 1994; Ruberg & Taylor, 1995] and higher participation rates [Hartman, Neuwirth, Kiesler, Cochran, Palmquist, & Zubrow, 1995]. Without the cues that can sometimes stifle contributions, otherwise quiet students might find a voice. Howard Rheingold [1994] enthuses about the potential of this anonymity, commenting that people find "virtual communities treat them as they always wanted to be treated - as thinkers and transmitters of ideas and feeling beings". (p.26) Given that one of our main aims in teaching is to help students explore their potential as "thinkers and transmitters of ideas", CMC offers considerable possibilities.

The filtered-cues approach to CMC also noted the related presence of disinhibited behaviour online [Kiesler, Siegel, & McGuire, 1984]. Without the usual non-verbal cues and well established etiquette that exist in FTF exchanges, we are less likely to feel constrained by convention. With the applicability of FTF norms in question and the repercussions of violating such norms less immediate, CMC has been associated not only with higher levels of self-disclosure, but also more antisocial behaviour. The very features permitting greater equality allow the expression of negative emotion as Howard Rheingold [1994] explains:

> The same lack of social feedback that lowers inhibitions enough to promote self-disclosure among groups of people can also lower inhibitions enough for individuals to disrupt those groups and sometimes tear the delicate fabric of trust that has been carefully woven over months of conversation among disembodied strangers. (p. 185)

Such behaviour is the antithesis of the mutual respect that we aim to foster in our teaching. Yet the filtered-cues position interprets antisocial behaviour as an inevitable consequence of the anonymity of interactions online. Is all teaching in cyberspace doomed to outbursts of aggression? Joseph Walther [1992], the proponent of the social information processing perspective (SIP) suggests not.

Of central importance to our project was the emphasis on relationship within SIP. SIP suggested that, far from being an anonymous medium, CMC can be as deeply relational as FTF interactions; all that is required is sufficient time and message exchange. CMC is relational, Walther argues, because of our strong desire for affiliation. As essentially social beings we are driven by a need for association and connection. Although the narrow bandwidth denies us non-verbal cues, we adapt to the medium and use textual cues to form impressions of others [Lea & Spears, 1992]. When relationships are developed, anonymity and disinhibition are reduced and antisocial behaviour is less likely. It is not surprising therefore to find that flaming, deliberately insulting or provocative messages, is more prevalent on large lists where it is easier to remain anonymous rather than in private email [Thompson & Ahn, 1992, cited in Walther, Anderson, & Park, 1994].

The two positions, filtered-cues and SIP, are generally conceptualised as diametrically opposed explanations of CMC, however, both are required to adequately describe the process of cybereducation. The features of CMC do render users vulnerable to outbursts of disinhibited and antisocial behaviour, however, SIP offers strategies to counter the negative effects. The tension for us as educators is developing a level of anonymity with its concomitant benefits, as described by the filtered-cues approach, while fostering the commitment and depth of relationship, predicted by SIP, sufficient to produce a sense of community. In our attempt to juggle these demands we decided to focus the students in a conscious way on the use of the pseudonym or alias.

We hoped that the self-reflexive use of pseudonyms would have a number of advantages. In contrast to the complete anonymity described by the filtered-cues position, the use of pseudonyms creates a context of "managed ambiguity" [Jaffe, Lee, Huang, & Oshagan, 1995]. Day and Batson [1995] describe this pseudonymity as allowing "a freedom to experiment with one's usual voice" (p.42). This experimentation could be particularly valuable in male-dominated disciplines such as Engineering or Computer Science, where adopting a genderless personae or being a virtual male might give women more confidence to contribute to discussions, with attention no longer focused on the sex of the speaker. Considering the male-dominated culture of the net which can intimidate female users [Spender, 1995; Turkle, 1996], gender-masking or gender-neutrality might be used more broadly within cybereducation as a strategy to encourage female students.

Without cues to signify the user as female or male, we might feel less bound by the traditional sex-based constraints on communication. Research suggests that, although women are more likely to mask their sex than men, in a context of pseudonymity men are more likely to change their behaviour, adopting more stereotypically feminine ways of communicating, such as the use of statements that support and encourage other users [Jaffe et al., 1995]. The development of a "learning community" has been posited as central to successful virtual teaching [Wiesenberg & Hutton, 1995]. To have both sexes equally encouraging and supporting of others might be considered important to the development of this community.

Personal Identity and Community in Cyberspace

In 1996 we developed a new semester-length subject called Personal Identity and Community in Cyberspace. The subject was part of a compulsory liberal arts program. All undergraduate students are required to complete three units from the program. The aim of the subject was to explore, theoretically and experientially, the meanings of identity and community in cyberspace. For example, how might our sense of who we are be constrained in interactions where the physical body does not exist? How might it be more fully realised? What are the implications of the ease of identity play in the virtual context for RL interactions? Without conventional geographic and ethnic markers, are new kinds of communities beginning to emerge? How do these new communities inform their RL counterparts?

Our aim was to immerse the students in the technology; to have the process of the subject, that is researching and interacting in cyberspace, become the content through a practice of critical self-reflexivity. All interactions took place online, with the exception of a final FTF meeting. We used FirstClass, a closed email and conferencing system that is user friendly, allowing students to develop a high level of competency quite quickly without any training. Within FirstClass, students submitted weekly journals, discussed key themes in the subject, as well as worked on and submitted a group project. There were also places, both synchronous and asynchronous, to socialise. Our initial intake consisted of 20 students.

We asked students to select an alias at the beginning of the semester. They were known by this pseudonym in all interactions. Research suggests that our name is an important signifier of our identity [Bechar-Israeli]. However, this name is usually chosen for us. An alias or nick, unlike our real-life (RL) name, is self-chosen, and can therefore be used to conceal or highlight our sense of self. An online alias is often, although not necessarily, "chosen to hide explicit identity, yet simultaneously reveal a personal facet of the author" [Jaffe et al., 1995].

The students' first task in the subject was to write a journal entry about their choice of alias. This was their first opportunity for self-reflexive analysis. In writing about the name they had chosen they were invited to think about the process of creating an identity. Although some students reported that they didn't give much consideration to the alias they chose, as the semester progressed, they were challenged to see that names they adopted nonetheless provided powerful cues for the impressions other students formed.

Lessons from experience

The delights of pseudonymity

As predicted by the filtered-cues position, the online environment allowed some students to find a strong and confident voice. Some students commented that they were more confident and contributed more online. The most positive observation was the reduction of cultural barriers. RMIT has a high proportion of Asian students, many of whom are international students, and as a university we are continually trying to address the issues raised by internationalisation. For a number of reasons, including cultural differences in educational expectations, as well as language confidence, Asian students are sometimes quiet in class [Ballard, 1991]. Of our first intake of students 20% were Asian. One of these in particular commented on the difference between his behaviour online and in FTF classes, "Comparing to FTF I do not say much unless teacher asks me, but online I write heaps ".

Balanced against this advantage is the stress for some students of communicating using only the written word. Another Asian student, Coconut, who fell behind in his work, noted the difficulty of communicating in a completely text-based medium: "It is ... hard for someone to exchange their opinion or information through the word ... especially for someone that do not have good english background ... but, i can do very well in chinese". While the issue of written expression arises for many of these students in FTF classes, written work is generally balanced with oral papers and group participation.

We also observed that interactions across cultural groups seemed to take place more easily online. While cultural markers were often evident in expression in email messages, in the more casual real-time talk, where abbreviations and misspellings are frequent, they were less obvious. Students talked about forming relationships across cultural boundaries, when in RL they felt more comfortable within their own cultural group. The benefit of getting to know each other online without meeting FTF was commented upon favourably by many students. Ramona summarised many students' reactions in the following comment:

> I think that we should be grateful for having the opportunity to meet each other [online] and talk to them for a few months before meeting each other ... When you meet someone in real life too many things get in the way for you to be able to talk to someone properly.

Reiterating Ramona's thoughts, Cougar sent the following reflection after meeting one of the other students in RL: "I would not have gone near him ... the physical perception put me right off ... then I thought wait on a sec, if I get on so well online maybe I should give him a chance. As it turned out, it was worth it". In FTF classes, first impressions make us more receptive to the ideas and arguments of some students. This is not to say that impressions are not formed online, because not only are they formed, but our observations and experience suggest that they act as powerful schemas that can be resistant to change[1]. However, these impressions are more likely to be based on ideas and the expression of these ideas than age, race, sex, or looks. A focus on the others students as "thinkers and transmitters of ideas" was evidenced in the strong critical approach they developed to each others' contributions.

Previous experience with newsgroups as well as existing research [for example, Gregor & Cuskelly, 1994] led us to expect a certain informality in online communication. We were not prepared, however, for the level of playfulness among the students. A lot of this play took place between the characters the students created through their alias. For example, Just Another Wolf opened many of his messages with "Grrday" or "Howlo" and sent his journals as text wrapped around elaborate ascii figures of a wolf. Tiger and Cougar joked about eating Rabbit for dinner. The students were also playful - flirtatious and cheeky - with us. This playfulness was particularly obvious in the social parts of the subject, the Personal Identity Pub, an asynchronous bulletin board, and in real-time chat. Many of the students evidenced a strong sense of community in the subject and these social, playful places seemed to be important in facilitating the development of that community. Walther's hypothesis that time is required for the relational nature of CMC to develop was supported: in general those students who spent more time online, particularly in the real-time chat, were those with a stronger sense of the class as a community.

Day and Batson [1995] caution against categorising online play as frivolity and they challenge teachers to develop appropriate practices for the "different psychological environment" that is created by CMC. We were, at least initially, guilty of this categorisation, experiencing a tension between the need to allow students time to interact socially and our desire to get through the syllabus. At times we felt as if the students were enjoying themselves, but we wondered how much they were learning. We were fortunate, however, in that the process of character play was integral to the subject. Students were encouraged therefore to deconstruct their play.

Lessons from experience

The dangers of pseudonymity

Given the strong sense of community that developed, it was not surprising that commitment to the subject was high and antisocial behaviour was infrequent.[2] Consistent with SIP we observed that students who took on the

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[1] See, for example, the classic study of self-fulfilling prophecy in a primary school by Robert Rosenthal.

[2] As in most subjects, some students demonstrated a low level of commitment, submitting very little work and spending little time online. It is, however, difficult to attribute this to pseudonymity as these few students tended to use their real name in correspondence with us. Lack of commitment was correlated with low levels of interaction early in the subject. Students who experienced difficulty with the software early in the semester and were not online to take part

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socio-emotional roles in the group, encouraging other students to contribute, were those more likely to self-disclose. Even these students, however, engaged in playful insults, suggesting that a norm of teasing, playful provocation had been established. On a more serious level, early in the semester an alias was stolen and used to flame another student. Several students registered their disbelief at this behaviour and some discussion of the role of trust ensued. Students called on the person responsible to own up, but no one did. The incident was a significant one in the history of the class and it formed the basis for one of the group projects.

All other negative disinhibited behaviour was confined to one student, Hashmann. Hashmann was a homeboy, a rap freak with a black American accent. When Hash was online, "Da man waz in da' houz". From his first post Hashmann was aggressive. He swore, wrote in capitals, and flamed other students who made moderate and sensible suggestions. He disagreed with most comments made, including our own, and was sexist.

Hashmann was distinguished not only by his online aggression, but the persistence of his virtual personae. Other students had well developed characters, for example, Just Another Wolf sent pictures of himself in his wolf costume and wrote about his experiences in FurryMUCK, however, he moved consciously out of character when he wanted to speak as Keith rather than J.A.Wolf. Hashmann never moved out of character even in his personal interactions with us. On one particular occasion when he was reprimanded by one of us for aggressive behaviour he responded in a private email, saying "you got some nerve lady!" He seemed to delight in his enigma, stating that we did not know who he was and therefore could not presume to understand his motivations.

We found Hashmann an interesting, albeit somewhat frustrating, personae. Having him in the subject was useful in that his behaviour raised questions that were central to the subject, to life online, and, importantly, to our teaching practice. Hashmann's behaviour caused us to rethink the roles of students and teachers.

The Process of Depaysement

Our experiences in cyberspace have fed into our FTF teaching and have been instructive in shaping our plans for our second intake of students in the online subject. The use of aliases offered a rich source of information for both us and the students. In our subject the process of pseudonymity was an integral part of the content of the subject, however, our findings suggest that the use of the alias might be valuable even when self-reflexive analysis is not an explicit component of the curriculum.

Teaching in cyberspace has provided us with an opportunity for depaysement, challenging us to (re)view our FTF practice. As a result of our experiences we have (re)considered the implicit norms that we and our students have internalised. We are (re)seeing the role of creativity in teaching and learning, and (re)appreciating the value of play, and the importance of the "learning community". The process of depaysement can be an uncomfortable one, as the strategies from our FTF teaching are often tried and comfortable. Pushing beyond these takes energy and commitment, but as Day and Batson [1995] argue, "holding on to the traditional makes it harder to see the opportunities" [p.37]. We can not assume that the skills and pedagogy of FTF teaching will be appropriate in cyberspace. We have to be open to change and open to the lessons, both in their delights and their dangers, that teaching online can offer.

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Enhanced Learning with Desktop Videoconferencing:

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Abstract This study describes participants' reactions to school/university activities that were enhanced by connecting distant sites via desktop videoconferencing. During this study teachers, school students, university faculty, and preservice teachers designed and/or conducted activities that provided for individuals to collaboratively problem-solve and obtain multiple perspectives during learning. The study describes participants' reactions to desktop videoconferencing activities and identifies and discusses variables that promote and/or limit such activities.

Background and Objectives

Distance technologies offer opportunities for linking two or more classrooms together so that students can collaboratively problem-solve and obtain multiple perspectives during learning. In addition, distance technologies provide teachers, preservice teachers, and university faculty with opportunities to collaboratively design curriculum and activities. However, most distance technologies are expensive, difficult to access, and complex to manipulate [Newby, 1996].

Desktop videoconferencing (DVC) allows users to participate in meetings with one or more people at distant sites using a personal computer, videoconferencing software, and a digitizer camera. To support our university/school activities we had affordable QuickCams™ coupled with free CU-SeeMe™ software at various school and university computers. CU-SeeMe™ software provides for conference participants to see and hear each other and in addition to write messages in a talk window.

Desktop videoconferencing's affordability, accessibility once purchased, and ease of use make it an excellent means for supporting communication needs of partnership programs. It appears to be an important technological innovation for connecting teachers and students. However, so far DVC has received little research attention. This study describes school activities that were enhanced by connecting distant sites via DVC and participants' reactions to those activities. Moreover, the study identifies and discusses variables that promote and/or limit such activities.

Desktop videoconferencing facilitated activity in two funded projects, GTech and Cultural Connections. In GTech teachers in nine middle and junior high schools collaborate with university professors to develop curricular activities that integrate science, mathematics, and technology. In Cultural Connections teachers, professors, and students conduct curricular activities via distance technologies to enhance student achievement, self-esteem, and multicultural understanding.

Theoretical Framework

Reform efforts in education have supported schools and universities as complementary partners in the preparation of teachers and the development and delivery of effective instruction in schools [Goodlad's Postulates, Professional Development Schools, 1990; Sizer's Coalition of Essential Schools, 1993; The Holmes Group, 1990; and The Center on Organization and Restructuring of Schools, Prager, 1992]. In addition, cross-classroom collaboration among school students is being encouraged as a means for learning language skills, new perspectives, increased multicultural understanding, awareness in the international arena, and cooperative patterns for tackling problems and issues [Riel, 1995]. Considering the increased support for collaboration, one would expect such partnerships to flourish. But the seemingly simple task of getting people together can be logistically difficult. Distance technologies might minimize the limitations of time and distance, and reduce travel and personnel expenses.

While several studies have described videoconferencing activities to support school/university and cross-classroom partnerships [Cable in the Classroom, 1995; Cifuentes, Sivo, Reynolds, 1997; Gibson & Gibson, 1995; McDevitt, 1995; Perraton, 1993; Riel, 1995; Strommen, 1995], little research has been done to explore the instructional utility of desktop videoconferencing. In this study we explore the extent to which participants find DVC educationally rewarding, factors which contribute to sense of reward, what makes DVC activities work, what limits such activities, and how such activities can be improved.

Desktop Videoconferencing Activities

Through grants from General Telephone and Electric (GTE) and The Center for the Study of Collaborative Learning at Texas A&M University, GTech and Cultural Connections projects were initiated. In the contexts of those projects desktop videoconferencing facilitated three different year-long school and university collaborative activities. In one activity, preservice teachers connected with inservice teachers who formatively evaluated classroom lessons that they developed as part of their teacher training. The technology provided preservice teachers with a virtual field-based experience. In another activity, teachers and university faculty met via desktop videoconference to collaboratively develop integrated thematic units for middle school science and math with an emphasis on technology utilization. During the third activity, middle school age students and school teachers met to collaboratively solve academic problems and share cultural experiences.

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Methods

Participants

Participants in the study are 54 middle-school or junior high school teachers involved in GTech and Cultural Connections DVC activities and the many students in their classrooms. The teachers incorporated the DVC activities in their mathematics, science, English, and social studies classes or in their homerooms.

Design

This study was conducted using both quantitative and qualitative research methods with the four researchers collaborating in survey and interview design, data collection, analysis, and development of meaning. Contributing variables to overall sense of reward included (1) goal clarity, (2) professional goals met, (3) gain of perspective, (4) pursuit of interesting topics, (5) facilitation of communication, (6) facilitation of multicultural understanding, (7) provision of opportunities unavailable otherwise, (8) facilitation of learning, (9) ability to see each other, (10) receipt of recognition, (11) making job easier, (12) enjoyment by students, (13) enjoyment by teachers, (14) ability to dialog with other professionals, (15) ability to see and hear distant partners, and (16) ease of use. Qualitative analyses of open-ended survey questions and interviews related to perceived benefits and limitations will be used to identify variables that either contributed to or limited the DVC activities.

Data Sources

All teachers and students are given a survey to assess the perceived quality of the activity as facilitated by DVC. This Desktop Videoconferencing Survey (DVCS), [Cifuentes, 1996] was developed from several interactive video conference evaluation instruments prepared for a distance education course in response to reading *The development of an instrument to measure attitudes toward televised courses* [Biner, 1993]. Two distance educators confirmed the instrument's content validity. The two-page survey is comprised of both five-point Likert items and open-ended questions. There are 13 Likert items designed to represent variables pertinent both to the *activity process* and to the *activity's impact upon its stakeholders*. The first item on the DVCS, the item of most concern, elicits the extent to which the respondent feels that the activity is rewarding, while the remaining items address the relevant activity variables described above. Participants are asked to circle the most appropriate response, which ranges from "strongly agree" (5) to "strongly disagree" (1).

The four open-ended questions in the DVCS follow the Likert items and are designed to allow partnership stakeholders to express personal reactions to the partnership. The questions address the perceptions of preservice and inservice teachers and school administrators regarding: (a) what they learned from the activity; (b) what made the activity work; (c) the factors limiting the activity; and (d) what would improve the activity. Responses to the open-ended questions will be interpreted with respect to how desktop videoconferencing facilitates learning.

At several times during each semester the researchers met or corresponded with participating teachers to discuss perceived benefits or limitations of the activities. Notes taken during these sessions served as an adjunct data source.

Procedure

The data collected for this research were generated during project implementation, when teachers and students participated in desktop videoconferences. A sample of ten participating teacher filled out the DVCS. Likert item responses were tallied while open-ended question responses were semantically interpreted and categorized. In addition, researchers and teachers involved in the project met on several occasions during each semester to discuss the progress of the activities. One of the researchers took notes during meetings.

After lengthy discussion among the researchers about the qualitative survey data and contents of meetings, they achieved consensus regarding the findings. Triangulation is used as the method of analysis to provide powerful evidence of credibility: The researchers came to the study with varied backgrounds and experiences, and engaged in analytic discussion about the data. They differed with respect to age, faculty-student status, and formal background (e.g., educational technology, science education, and mathematics education).

Results

Implementation of activities was ongoing for two semesters. As a result of the collaborative activities via desktop videoconferencing, preservice teachers, inservice teachers, and students had rewarding experiences that they would otherwise not have had. While participants generally agreed that the activities had positive effects, they acknowledged that distance technologies cannot replicate face-to-face, live interaction.

All participants reported that they found DVC educationally rewarding. Factors that contributed to sense of reward included the abilities to "interact with teachers from other places", "bring the world and other classrooms across the state and nation into our school", and conduct "face to face research." Teachers commented that they appreciated the increase in technological skill for themselves and their students. One teacher liked "dealing with peers outside of the school setting" and one teacher liked "the ability to communicate immediately and ask questions directly to those "in the know." When comparing DVC to large-group interactive videoconferencing the four teachers who had done both large-group and desktop videoconferencing with their students described DVC as much more "personal" and "individualized".

Limiting factors for use of DVC, especially when compared to interactive videoconferencing included limited access, time, technical skill, and audio/visual clarity. Teachers expressed the problem of managing the learning activity when "only a few students can access the computer at one time." Others expressed the problem of limited access to the Internet. In addition, coordinating meeting times with distant partners was time consuming and complicated. Two teachers expressed the need for "set up times for people to interact" and time for "pre-planning of lessons or research." Two other teachers expressed a need for 'more training and experience with people that are comfortable using" DVC. In a discussion teachers agreed that they needed more sites with which to interact, access to more cameras, and faster modems. Several teachers described problems with audio and/or video clarity once on the system.

The ten surveyed teachers briefly described the ways that they used DVC as follows: Three teachers said that their students used DVC to interview distant students. Three others' students talked to students to learn about other cities in other states. A couple of teachers used DVC for "class presentations. Two teachers used DVC to critique and formatively evaluate university preservice teachers' multimedia lessons. one teacher used it to make presentation and to "interact with other teachers as a part of her own professional development."

In addition to rating DVC as rewarding, surveyed teachers felt positive about goal clarity, and DVC as a facilitator of communication and provider of otherwise unavailable opportunities. While most surveyed felt that their students learned from the opportunity to meet with and see distant others, some felt neutral about its benefits to their students. Likewise, while teachers generally enjoyed DVC and felt that their professional goals were being met by the opportunity to gain others' perspectives, pursue topics of particular interest, and dialog with other professionals, some felt neutral about its professional benefits to them. Teachers were less positive about the amount of recognition they get for using DVC, its contribution to job ease, and most significantly for a group of 4 teachers, their inability to hear the audio clearly.

One of the most positive findings was that eight teachers strongly agreed that DVC facilitated cultural understanding while only two were neutral on this point. Also, eight planned to continue using DVC while two were neutral. No participant felt negative about DVCs effects or its future application (see Table 1).

Item	SA	A	N	D	SD
Sense of reward in teaching	5	5			
Sense of reward for students	5	4	1		
Goal clarity	4	6	1		
Professional goals met	3	4	3		
Gain of perspective	3	3	4		
Pursuit of interesting topics	4	3	3		
Facilitates communication	7	3			
Facilitates cultural understanding	8		2		
Provides opportunities we wouldn't otherwise have	7	3			
Facilitates learning activities	8	1	1		
Meeting with distance partners facilitates learning	6	3	1		
Being able to see each other facilitates learning	6	3	1		
I receive recognition for participation	3	2	4		1
DVC makes my job easier	2	1	6	1	
My students enjoy DVC	8		1	1	
I enjoy DVC	5	4	1		
DVC facilitates dialog between professionals	2	1	7		
I could hear the distant partner clearly	1	3	2		4
I could see the distant partner clearly	3	6	1		
DVC is user friendly	3	4	3		
I will continue to use DVC in my classroom	4	4	2		

Table 1: Responses to questions about the rewards of desktop videoconferencing. SA=strongly agree, A=Agree, N=neutral, D=disagree, SD=strongly disagree

Educational Importance

While time and distance limit the practicality of school/university and cross-classroom collaboration, distance technologies facilitate rewarding interactions between preservice teachers, inservice teachers, and students for virtual field-based, collaborative, and multicultural experiences. Identifying factors that contribute to or limit successful application of distance technologies is an important area of investigation for anyone interested in instructional interactions via distance technologies.

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Promoting Multicultural Understanding Through A Distance Learning Community

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Abstract In this study we explored the effectiveness of distance learning and multimedia technologies in promoting multicultural understanding among teachers, thereby facilitating increased: 1) school achievement, 2) self-esteem, and 3) multicultural understanding among students. In addition, in collaboration with university researchers, teachers developed both curricular activities and identity-forming multicultural activities for their students to conduct over the distance. Students partcipated in collaboration activities and shared multimedia files with other students via interactive videoconference, desktop videoconference (CU-SeeMe), and computer conference. In this cross-classroom collaboration, predominantly Hispanic students in the Rio Grande Valley of Texas communicated regularly with diverse students in two schools hundreds of miles to the north. Using qualitative research methods, we discovered that the participating teachers and students developed communication and leadership skills as they increased cultural sensitivity.

Objectives

Learner-centered schools must honor diversity and emphasize how similarities foster unity [Texas Education Agency]. Therefore, students, teachers, and administrators must build on similarities that strengthen bonds, among the members of the learning community. In this study we explored the effectiveness of distance learning and multimedia technologies in promoting multicultural understanding among teachers, thereby facilitating increased: 1) school achievement, 2) self-esteem, and 3) multicultural understanding among students. Cultural Connections is an extension and expansion of Project Footsteps [Cifuentes, Metcalf, Webb-Johnson, Murphy, & Davis, 1996]. As with Project Footsteps, the purpose of Cultural Connections is to promote collaboration and cross-cultural understanding among secondary teachers and students across geographical distances using distance learning and multimedia technologies. In this cross-classroom collaboration, predominantly Hispanic students in the Rio Grande Valley of Texas conferred regularly via distance technologies with diverse students hundreds of miles to the north.

Teachers collaboratively developed curricular multimedia/distance learning activities for their students. Cultural connections gives teachers meaningful applications of technology in their classrooms and opportunities to build professional relationships with teachers across diverse school sites. The project provides students with the tools to explore and present who they are to culturally diverse audiences. Students have opportunities to respond to presentations by other distant students' and to get feedback from others about their own presentations in order to heighten awareness of diversity.

Theoretical Framework

Low school achievement and high drop-out rates among disadvantaged groups are closely connected to social, cultural, and geographic isolation. Isolation inhibits personal identity and growth by limiting horizons and awareness of possibilities. To prepare for the increasingly interconnected world of the 21st century, teachers need to help students become more aware of various cultural traditions and to respect and appreciate their own and others' cultures [Greenfield, 1996; Zeichner, 1995]. Developing respect for one's own culture helps to overcome lack of pride and confidence, which obstructs achievement and school completion [Slavin, 1995]. In addition, cultural exchange can foster understanding among people of diverse cultures [Banks, 1994].

Distance technologies expand the range of opportunities for students to build relationships with people of different cultures. In the current social-constructivist conception of learning, "education is the shared way of thinking about one's self, the community, and the world" [Riel, 1995, p. 219]. Schools might play a significant role in nurturing students' positive identity formation by providing them with opportunities to build distant relationships. In order to transform into more tolerant and respectful citizens, students need to develop relationships with people from diverse cultures and backgrounds (Moffett, 1994). Geographical and cultural isolation can limit opportunities for relationship building beyond one's culture. However, cross-classroom collaboratives allow students to connect with distant others from around the world. The collaborative learning process has the potential to transform individual participant's perspectives from parochial to global [Cummins & Sayers 1995; Metcalf, 1994]. In Cultural Connections, multimedia software and distance technologies were used to eliminate isolation. Student development of multimedia portfolios and cross-classroom collaboration were meant to foster the building of multicultural relationships while honoring the strength of diversity and emphasizing how similarities unify.

The Project

In collaboration with university researchers, teachers developed identity forming and multicultural curricular activities for their students to conduct over the distance. For instance, they developed multimedia activities from writing activities in *I Thought I Was from Another Planet* [Dresser, 1994], which was designed to help students develop authentic writing voices and heighten their sensitivity to our multicultural world. Students did the activities, which involved writing and distance collaboration, and ultimately produced multimedia presentations of their work which they shared over the distance.

Another activity involved a distance open forum to discuss the pros and cons of school uniforms. Students conducted library and Internet research on the topic; they surveyed campus students and faculty; and they formulated, developed, and presented persuasive arguments across the distance.

Cultural connection used the combined power of multimedia and distance technologies to motivate diverse and geographically separated students to visualize and write about and share with each other who they are. In HyperStudio™, one of the multimedia software programs used by students in the project, students wrote and visualized volumes about their home lives, their goals, their thoughts and values, their likes and abilities, and their stories. The scrolling text option allowed them to place several essays in their multimedia portfolios. Students were forced to reflect critically upon their understanding of their experiences in a social context beyond their immediate communities. They shared multimedia files with others via interactive videoconference, desktop videoconference (CU-SeeMe), and computer conference. Presentations were projected before a class, viewed individually, and/or viewed in small groups. Files were stored by students as they generated ideas and received feedback from each other. In addition, and perhaps most importantly, because multimedia software files are easily edited and revised, students could change their presentations as they themselves grew and changed.

Methods

Cultural Connections included Berta Cabaza Middle School in San Benito, Texas, which is located in the Lower Rio Grande Valley; Jones Intermediate School in Waller, Texas, which is located about 350 miles to the north of San Benito; and Somerville Junior High School in Central Texas. Participants in this study included teachers and their students, school counselors, school principals, university faculty at Texas A&M, and a trainer at an Educational Development Laboratory. Sixteen teachers at Berta Cabaza, six teachers at Jones Intermediate and two teachers at Somerville Junior High who teach math, science, language arts and social studies conducted Cultural Connections curricular activities. A counselor at Berta Cabaza partnered with a counselor at Somerville Junior high to conduct guidance activities. School principals, and university faculty facilitated the project. This study included descriptive statistics associated with the ten fifth grade students from Jones Intermediate and twelve eighth grade students from Berta Cabaza who were active in the project throughout the 1996-1997 academic year. All student populations in partcipating schools were racially and culturally diverse, and participating students equitably represented the student populations of each school. The school and university partners were equipped with interactive compressed video systems, HyperStudio™ software, Internet connections, CU-SeeMe™ software, and FirstClass™ computer conferencing software.

Design

This study reports participants' reflections upon Cultural Connections and on the progress of one partnership between two teachers, one at Berta Cabaza and one at Jones Intermediate, toward meeting project objectives. This investigation relied on ethnographic methods. Data sources included videoconferences, student portfolios, student interviews, students' and teachers' reflective journals, evaluations of the annual videoconference, and student records.

Participating students prepared presentations that they delivered orally via videoconference to partners at distant schools. In addition, participating students created and maintained multimedia HyperStudio™ portfolios containing collected works about their homes, thoughts and values, goals, likes and abilities, and stories. The portfolios were under continuous construction and reconstruction by the students and served as valuable disclosures of adolescents' feelings about their experiences with distant partners.

We interviewed participating students and spent time as participant observers in the classroom during distance activities and multimedia development, keeping records of our experiences and observations. We asked such questions as, "What are you learning from developing your multimedia portfolio?" "What are you learning from meeting with your distant partners?" "What are you learning from seeing distant others' portfolios?" and "In what ways are you similar and/or different from your distant partners?"

In addition, students and teachers kept reflective journals of their experiences, observations and insights during and after implementation of the project. These journals served as rich resources, as the teachers were able to report on observed changes in their students whom they saw on a daily basis throughout the year.

An Annual Distance Learning Conference has been an important benchmark for Cultural Connections. For two years this conference has brought participating teachers and facilitators together for planning and technology training. The final activity at the conference has been filling out conference evaluations. These evaluations provided insight into teachers' attitudes toward the project and anticipated and felt effects of the project.

We analyzed and evaluated the contents of the videoconferences, multimedia portfolios, interviews, reflective journals and conference evaluations for recurrent themes regarding issues related to the effects of the technology on (a) school achievement, (b) enhanced self esteem, and (c) enhanced multicultural understanding.

We triangulated the data by obtaining multiple points of view from our own observations of the students and their work, teachers' logs, and principals' observations.

In addition, we are collecting descriptive data regarding student achievement on the Texas Assessment of Academic Skills (TAAS), attendance, conduct, and discipline referrals. Later, we will compare the year prior to Cultural Connections participation with the year of participation to determine the extent to which project participation made an impact upon those factors.

Results

Descriptive statistics that would provide evidence regarding the impact of the project on academic achievement and self-esteem are still to be identified and will be included in later reports; 1996-1997 academic reports will be completed in May of 1997. At that time we will report the statistics in a table and analyze the results. However, the other data souces alone reveal positive effects of the project.

Observations during videoconferences, contents of student portfolios, interviews, and reflective journals, and contents of teacher reflective journals and videoconference evaluations all provide evidence that Cultural Connections enhanced the teaching experience while increasing students' self-esteem and cross-cultural understanding. The themes of growth, empowerment, need for mentorship, and comfort with technology emerged from the various data sources. Each of these emergent themes indicate that the project was a powerful initiator of positive change.

Increased Self-Esteem

Teachers reported that they observed increased poise, communication and leadership skills, and technology proficiency among students. Students involved in Cultural Connections grew and matured in many areas, including increased cultural sensitivity. A teacher reflected on her experience and observations saying, "The positive relationships and friendships that have grown out of Cultural Connections are so powerful....As our students communicate via distance technologies and develop projects, they become more effective collaborators, communicators, writers, researchers, analysts, and artists." One student offered, when asked what she was learning from the project, "Technology! The wonders of it!" Another student indicated that her distance learning experience was so valuable it was worth sharing: "I can go home and share the cultures with my family."

Increased Mulitcultural Understanding

We found that distance learning and multimedia technologies proved effective in helping young adolescents make sense of their experiences and in promoting multicultural understanding. For example, after several videoconference interactions one student wrote, "Distance learning helped me to understand other cultures. I also made friends through the connection. It helped me understand what the future will be," and another explained, "I interacted with people of differenct races. It was fun meeting new people, and getting over my shyness for speaking in front of people." Several students noticed similarities between themselves and the distant students; "Our culture is not much different from theirs;" "We all get shy and nervous sometimes, but we also know that we are comfortable with each other;" "We all want a good education." Other students highlighted differences (perhaps based on misconceptions). For instance one student said, "They seem higher class because they are Anglo. They don't have to worry about fights and gangs because there aren't as much. You see them and it's like they have no problems at all." That same student said that the only similarity she could see was that she likes volleyball and one of the distant students does too.

Perhaps the project will have the power to dispell misconceptions among participants. One counselor wrote, "Role playing each site's different struggles, and then discovering solutions between the two locations is exciting.Somerville students realizing that San Benito students deal with the same adolescent difficulties...There are no barriers between the 300 miles that separate us."

A teacher said that her students, who were entirely Mexican-American, reacted favorably to becoming acquainted with students from other cultural backgrounds. She observed, "As I viewed a videotape of the conference, it was evident that my students were not used to listening to or conversing with Black students.... It was not an instance of racism, but a clear-cut instance of pure curiosity that had shown on their faces.... One of my students seemed prideful in announcing that he was the Black student's key pal." Students who tended to be absent attended school more regularly in order to participate in video conferences, and their personal grooming habits improved. One student with serious discipline problems improved his behavior and his grades in order to participate. In addition, observation revealed that participating students became leaders among their peers.

Educational Significance

Dewey (1938) [Dewey, 1938] defined growth as the ability to secure meaning from experience and to act in ways instrumental to the achievement of worthwhile ends. In Cultural Connections, diverse students across Texas collaborated on multicultural activities which helped them grow. Cross-classroom collaboration made it possible for young adolescents to expand their world-views in preparation for contributing in our increasingly multicultural environment. This project demonstrates that in networked classrooms students can connect with people from around the world to learn about and from the perspectives of others and to increase their multicultural understandings.

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Europe's approach to New Technologies in Education : Government vs. Industry

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Abstract : The purpose of this paper is to give an overview of some initiatives taken in the area of information technology and education within the framework of the European Union. The authors identify trends and describe challenges faced by the European educational community in the implementation of a new vision of the schools of tomorrow. More specifically, the authors describe the process by which projects are launched at the European Union level followed by a description of transnational and national activities. Finally, a more in-depth description of initiatives taken at the European industry level will be presented with special emphasis on the European Round Table of Industrialists (ERT) projects. Highlights and general trends which emerged from interviews conducted during the study regarding the vision for the schools of tomorrow will be presented.

I. Initiatives at the Level of the European Union

The European Commission (EC) operates at the very heart of the European Union. Its first task is to initiate European policies, in close partnership with the other European institutions and with the Governments of the Member states. The European Commission is divided into 24 Directorates-General (DG). These DG's represent broad areas of societal issues. The work of DG22, for example, encompasses activities concerning Education, Training and Youth. In the past large programs have been launched (and are ongoing) like Socrates, aiming at promoting European cooperation in Education, with as specific activities e.g. to promote the intercultural dimension of education and to encourage contacts among pupils of all types of schools. One area where the EC actively promotes cooperation is in Open and Distance Learning. The EC typically stipulates conditions under which grants can be obtained to participate in the program; e.g. partnerships between different European countries and between different actors in the field involved. Other big programs in the field of education are Leonardo daVinci (for training), and TEN which supports the development of communications and telematics applications. Most recently the EC has launched the action plan for a European education initiative (1) which aims at accelerating school's entry into the information society by giving them new means of access to the world, (2) which encourages the widespread application of multimedia pedagogical practices and the forming of a critical mass of users, products and educational multimedia services. The necessary funding will be obtained from a variety of sources within the different programs of the EC. However, the EC encourages permanent partnerships between public and private sectors for channeling resources as well.

II. Initiatives at the Transnational level : a Virtual University for Europe

EuroPace2000 is a trans-European network of universities, enterprises and organisations with an interest in the field of distance and continuing education and training. EuroPace2000 has 60 member organisations all over Europe, 45 of which are universities. By using various models EuroPace2000 demonstrates and develops the potential of telematics for the European university of the future.

III. Initiatives at the National Level : The Swedish Example

A few years ago the Swedish government formed the "Foundation for Knowledge and Competence Development". The foundation operates with a fund of approximately US$ 1 billion and has three major tasks : (1) support research at small and medium-sized colleges, (2) favor exchange of knowledge between universities and companies, (3) increase the use of information and communication technologies (ICT) in society. We will elaborate on this third task.

To achieve the goal of increasing the use of ICT money is mostly spent on projects in schools. The Swedish program for the advancement of ICT in schools spends more than US$ 100 million over a period of three years. The program started in late 1995 and is concerned with schools for children from 5-19 years old. The main objective is to reform the Swedish school system. Therefore the basic criterion for supporting projects proposed by schools has been the type of pedagogical approach adopted. Financial support is given to projects where the role of teachers and students changes. The approach must be student-centered (based on the questions and initiatives of students) rather than teacher-centered. It is not the number of computers that is decisive for gaining support, however, all projects funded should integrate ICT in their new approach. The Foundation believes in ICT as a tool for the student to search for the information needed to construct his/her knowledge in collaboration with other students inside and/or outside the school.

The Foundation proceeds as follows :

(1) School development projects

The foundation supports more than 70 projects all over Sweden. The local administration pays 50% of the costs. Money from the Foundation may not be used for the purchase of hard- and software. It should be spent on the education of teachers, extra employees and so on. At present, the Foundation supports 27 big projects with a maximum of $750 000 per year (cities, counties) and more than 40 smaller projects with a maximum of $150 000 per year, in both cases for three years.

(2) Teacher Training

The Foundation provides $11 million to introduce teachers all over Sweden to a new way of teaching.

(3) Seminars

Now that the projects have been chosen and are set up, the Foundation focuses on the dissemination of the results of these projects to other schools. This is done by arranging seminars and conferences. In addition, a newsletter is produced and distributed to all schools in order to give all teachers an opportunity to know what is going on.

Seminars are arranged for :

- Politicians. Local politicians are informed by colleagues who have decided to invest in schools wheere ICT is introduced in the learning process. The goal is to stress the importance of reforming education all over the country. Pedagogical and technical experts (university professors) support this message.
- Teachers. Teachers with experience of using ICT tell their less progressive colleagues hwo and why they have used ICT in their school.

(4) Educational materials

Great efforts are made to support the production of both non-commercial and commercial educational material.

The typical non-commercial production is an educational web-site. For example : three-dimensional pictures from the particle-collision experiments in CERN are made available on the net. The goal of the commercial program is to support a Swedish educational multi-media industry. International cooperation is favored, the Swedish market being probably too small for profitable investments.

(5) Research

Research on IT-didactics is supported in seven universities.

IV. Initiatives at the European Industry level : the European Round Table of Industrialists

The European Round Table (ERT) is a grouping of 46 chairmen of major European companies, representing a wide range of sectors of industry and coming from 16 European countries. Their main objective is to strengthen Europe's economy and improve its global competitiveness. Therefore, the ERT invests (among other activities) in research to make wide-ranging proposals for practical policies in order to contribute to the progress of the European economy. They are concerned with all major fields in society : *education*, employment, environment, export controls, infrastructure, North/South relations etc. In education, their previous report "Education for Europeans : Towards the Learning Society" [ERT 1995] has circulated widely to European and national decision-making bodies, to national and international organizations and to the general public. After this study was produced and was very well received it became apparent that a follow-up study was needed which would focus on the use of information technology in learning.

ERT study : "The use of information technology in learning : Investing in Knowledge"

The first ERT study stressed that there is an increasing gap between economic and social realities and the output of our education system. This follow-up study "Investing in Knowledge : The integration of Technology in European Education " [ERT 1997] focuses on the necessary educational reform in Europe in order to prepare its citizens for the knowledge society and to narrow that gap. Technology is not perceived as the driving force for this reform, but its potential needs to be explored as a tool or an instrument to support the necessary changes. The human perspective prevails and implications of introducing information and communication technologies are investigated at the level of the individual learner, the teacher, the educational leader and the learning community.

The ERT study was based on an extensive review of the literature and survey of 65 experts in 9 different fields of education[1] spread across Europe. The purpose of the survey questionnaire was to gain a qualitative insight into the problems, opportunities and challenges for education, related to knowledge and technology (r)evolution as perceived by the different actors in the field of education. The results of the interviews are meant to complete the knowledge extracted from the literature search and the expertise of a scientific committee. Different methods for onducting the interviews were used : face-to-face interviews (7), video-conferencing (27), telephone (20) and e-mail or written responses (11). The method of interviewing was a semi-structured direct interview.

V. Highlights, Trends and Challenges emerging from the Study.

1. The changing role and status of students and teachers leading to a need for teacher training

Learning in the future will require more self-regulation, self-discipline, collaborative learning, flexibility and creative thinking which will affect the role of the learners. Based on the judgement of the interviewees, the fears of teachers of being superseded by technology are clearly unjustified. The majority of experts (72%) considers face-to-face teaching and computer-base teaching complementary and therefore equally valid, depending for example on the subject to be taught or the type of technology used. A minority (28%) declares technology-based learning to be clearly inferior. For the majority of the respondents new technologies primarily are an additional learning tool.

A. New roles for teachers

Although consensus is attained on the enduring importance of the teacher in the learning process, the question still arises whether the role and status of teachers are subject to important changes. An overwhelming majority of the interviewees agreed with the idea that a teacher should become more of a "guide" than an information-deliverer. The concepts of *organizer, architect, coach, counselor, regisseur, resource manager, mentor, shepherd, moderator and facilitator* were used to describe the teachers of the future. Interestingly, a number of experts argue that this new role by no means eases the job of a teacher; on the contrary the demands on his/her competencies are growing and working with technology implies that there are incremental tasks to do above the face-to-face teaching. Teachers will have to master new technologies, but knowledge of the basic subject content remains equally important.

For many teachers these changes produce tensions, however their biggest frustration seems to be the lack of training in using new technologies.

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[1] The different fields in education are : university, open university, educational administration, industry, publishers, headmaster - (secondary, primary schools), teachers (secondary, primary schools), teacher training

Teachers need the following skills and competencies to use new technologies effectively :interpersonal communication, planning skills, collaboration teamwork skills (coordinating groups and interaction is more easy to achieve in a face-to-face setting), native language (and English) proficiency, writing skills, organizational skills, feedback skills, technical competency, seeing the big picture (e.g. being able to combine all fragmented information provided by the students)

university professor, France

B. *Teacher Training in New Technologies : barriers, content, modalities and recommendations*

Teacher training was vividly discussed when the interviewees were probed with statements concerning that issue. Although it's interesting to look at the number of agreement and disagreement obtained with these statements, it is more useful for our purpose to analyze trends in the answers provoked by the statements.

(a) main barriers to the adoption of new technologies

- there exist large psychological barriers to try and use computers and multimedia
- it is most difficult to change the pedagogical beliefs underlying teaching (student-centered or teacher-centered approach), as long as these stay the same, introducing multimedia and telematics will not affect the educational process. Fullan [Fullan et al. 1991] indeed confirms that educational materials and pedagogical methods are easier to change.
- (especially for older teachers) it is difficult to change deep-rooted mental structures on the "art of teaching"
- teachers are afraid of losing authority and class control because they believe their competency to work with computers and multimedia is inferior to that of the students
- the rapid pace of change in computer infrastructure and software results in "technical paralysis", teachers and schools cannot keep up with the speed in progress

(b) content of teacher training

- first, teacher training should motivate teachers and transform negative attitudes into the positive belief that teaching will be enhanced by the introduction of new technologies
- there is agreement that teacher training should provide teachers with the correct pedagogical skills to use multimedia and telematics in their own lessons. This is in general considered to be a priority in teacher training
- a question mark is put on the degree of technical know-how a teacher should have in order to use multimedia in his/her lessons

(c) modalities of training

Professional development in Europe isn't quite as widespread and systematic as in most places in the USA. Hence the concern from most of the interviewees on the following issues :

- the number of teachers to be trained per educational institution; should all teachers be trained simultaneously or should the most innovative teachers be trained first to later share their knowledge with their colleagues
- the timing of teacher training; ideas of sabbatical leaves, being trained in companies, are launched

Training is needed and not short training sessions grabbed in the evenings but a full and planned program when teachers are relieved of their teaching duties for large blocks of time

secondary teacher, UK

- training is wasted if it is not accompanied by giving the teacher enough time to implement their use of IT, and/or are even discouraged afterwards to apply the skills acquired in a content driven curriculum

(d) recommendations and conditions for success

- schools must provide sufficient infrastructure; e.g. one computer per teacher in school and access to the internet
- disseminate models of success and confront teacher with emergent good practices
- creation of a *teacher community*, e.g. in networking with other educational institutions at the local but by preference even at the European level, where teachers can exchange ideas, experiences and information. This will enhance experimentation and innovation and broaden ideas across Europe

2. Educational Settings of the Future

The interviewees supported the following statement in the questionnaire : "The introduction of information technologies in the institution demands a systematic approach , characterized by teamwork (including principal and teachers, among others) and it is primarily oriented towards school middle management (e.g. an activity coordinator) as the "drive" for change. However technologies can never be the trigger of real educational changes, they are only the medium that facilitates actual educational innovation.

A. The new principal : a (wo)man of vision, inspiration and cooperation

The experts stress the importance of the role of the principal of the future. He/she will have to be the driving force for the changes in the educational system and for the implementation of innovative thinking.

> *I have seen a whole school improving simply because the principal found the possibilities e-mail can create.*
>
> teacher trainer, UK.

The following profile is desired :

- principals become managers; they have to invest in management techniques and preferably spend some time in a company
- principals are not kings in a hierarchical monarchy : there is a need for an open culture and decentralized decision making : (1) teamwork with teachers, (2) possibility to engage outside experts when needed
- they develop (possibly in teamwork with their teachers and/or within a network of headmasters) a vision on the educational mission of their institution and make it operational in a strategic quality plan; they inspire all layers of their institution to adopt and realize that plan
- they are very flexible and adapt to changing demands from the society, again this refers to the openness of the culture
- they firmly support teachers in the adoption of new technologies by creating a psychological and physical space to experiment and try out new ideas; this might involve flexibility in the time-tables, providing the necessary infrastructure etc.
- they spend time on fund-raising since governmental funding becomes insufficient; e.g. by seeking partnerships with business. Skills in negotiating becomes a must
- they fulfill a public relation function towards the outside world; e.g. by sensitizing parents, local governments, local organizations (youth work etc.)

It is clear that the principal cannot assume all these tasks without things being changed at the macro-level of education. It is important that schools receive support at the governmental level of the educational system.

> *The management of an educational institution needs the power to make changes. Government has to take away barriers to innovation while giving schools autonomy.*
>
> open university, The Netherlands

B. Strategic management of resources

In essence, strategic management of resources should be a priority for the principal. He/she will have to be concerned with

- time management (e.g. flexibility in time-tables)
- management of space and infrastructure (e.g. retrofitting, space to accommodate cross-curricular activities and teamwork)
- human resources management (e.g. technical support for teachers, support staff for issues other than technical problems (e.g. new examination structures), providing teachers with larger pedagogical freedom and support them to engage in cross-curricular work)

- financial management issues; e.g. the majority of interviewees agreed that financing is a major problem in these effort to renovate education. The implications are indeed manifold; it requires investments in computer infrastructure, teacher training, increasing the support staff etc. There is some debate on the role of industry in providing money to realize educational changes. Should industry fund educational reform or should it remain the province of government as it has in the past ?

3. Educational software in Europe : food for thought.

Teachers are eager to use multimedia software and are in particular interested in having some control over the technology used. It became obvious that they wanted to be involved at the grassroots level and empowered with tools to truly integrate technology in their classrooms. They expressed a strong desire of being in control of enhancing their teaching by technology and doing so by familiarizing themselves with authoring systems which would allow them to create their own teaching materials. In addition, teachers strongly value the communication power that computers embody. They feel that would facilitate the creation of a much needed teacher/learner community. Networking was overwhelmingly considered a positive evolution; students, teachers and principals felt that they could reach out to the world. Vice versa internet and WWW bring the world into the classroom.

> "*There is no other way forward - there should not be an insular approach to education, with schools working in inward moving spirals but in outward ones, pooling resources and sharing expertise...The very nature of communications today (e.g. The Internet) makes this the case, and it is up to the educationalists to ensure there are no dangers to this.*
>
> Secondary teacher, UK

Both publishers and teachers are willing to cooperate from an early stage in developing good quality software, bringing in their own particular expertise. Moreover, the government needs to take some initiatives to inject life into the educational software market. An issue which remains to be tackled at the European level is the problem of language barriers. There is a need for translation in spite of difficulties of translating 'cultural-related' content and to transpose software to a different cultural environment.

VI. Towards Partnerships

Until recently, education policy has been mainly the province of government, particularly regarding funding issues. From the above, it becomes apparent that both public and private sector share a similar vision on the educational process of tomorrow using information technology and aim at similar objectives such as increasing the knowledge level of European citizens and to protect Europe's competitiveness in the global market. However, cooperation between the varied constituents will call for an open mindedness regarding cultural based beliefs (e.g. should industry fund schooling). Such issues will have to be solved. If schools are truly to enter the information society, it seems crucial to move towards partnerships at many levels; e.g. between education and business, between schools and educational software providers, and between schools, teachers and learners. Such powerful combination can lead to a real learning community and be a catalyst for a positive change in education.

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Geographic Maps as Navigation Tools in Educational Hypermedia

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Abstract: *The article describes the authors' experience in the construction of geographic interfaces for educational hypermedia applications. In systems based on the metaphor of maps different navigation paths are possible. The article presents the principal of these and highlights the nature of the tools (general primitives) that enable the student to exploit the map collection as an ontologically well-founded system for the retrieval and study of geo-referenced data. It shows that hypermedia applications of this kind require specialized and abstract data models that are difficult to implement in the hypermedia systems currently available on the market. It also shows that these applications are different from usual 'display oriented' hypermedia applications. The article then describes a number of prototype navigation tools obtained by extending the functions of a hypermedia system currently on the market.*

Introduction

Our interest in extending the functions of hypermedia systems to manage geo-referenced data originated in a project to develop hypertext teaching materials. During this project, a number of prototype hypermedia systems were constructed, representing problem classes judged of major interest. Some of the solutions adopted suggested that works traditionally described as reference materials (atlases, glossaries, concordances, etc.) are, metaphorically, *gates* among the corpora of traditionally distinct disciplines. If these works are transformed into electronic hypermedia systems, and if this operation is performed non-trivially, gates normally closed because of the natural tendency to specialization among scholars are thrown open. The results presented here arise from this conviction and concern development of a prototype hypermedia atlas. From a technological point of view, literary works are structurally different from a collection of nodes and links. Bieber & Kacmar [Bieber & Kacmar 95] have recently stressed this difference, distinguishing between display-oriented and computational-oriented hypertexts. Bieber and Kacmar give the example of a Geographic Information System (i.e. an electronic version of an atlas) to show that a user employing a tool of this kind is involved mainly in investigation of the reality represented in the atlas itself. In other words, the users of a GIS often perform actions which require calculations based on the geo-referenced data that constitute the system knowledge.

Three options are available in computational-oriented applications. The first is an expansion of hypertext systems (typically display-oriented) to include computational aspects, as in [Halasz 88] [Schnase & Leggett 89].The second is to extend the functions of a computational-oriented system to include hypertext technologies, and this is the road pursued in [Bieber & Kacmar 95]. The last option regards the availability of Open Hypermedia System (OHMS). In our opinion, a Computational Oriented system should interact with a Display Oriented system through a common protocol. The reader can find in [Østerbye & Wiil 96] a method for the classification of the opening degree of a hypermedia system. This paper includes specific bibliographical references to the most important approaches of Open hypermedia systems. In [Wiil & Leggett 96], the authors present their approach for a OHMS and discuss seven requisites that an open hypertext should have: *scalability, openess, distribution, heterogeneity, interoperability, extensibility, computation*. When hypertext technologies are used for didactic purposes, the option of expanding the functions of a computational-oriented system is not appealing. In fact, an educational course supported by hypertext technologies frequently involves the use of more than one computational-oriented package. Consider, for example, a university course in statistical data analysis. A hypertext containing the text of the lessons will probably be used, but almost certainly also a data analysis package like SAS™ or SPSS™, a DBMS, a symbolic calculation program like Mathematica™ or MATLAB™, a G.I.S. like MapInfo™ for the spatial representation of phenomena, and so on. To imagine that all these products include hypertext extensions, and further that these extensions are compatible, is somewhat unrealistic at the present time. Moreover, the problems raised by the introduction of hypertext primitives into applications using geographic metaphors are far from being resolved. In fact, the relation between geographical components and other components of a hypermedia can be interpreted in different ways (which we here call 'routes', see [The potential roles of geographical maps in a hypertext]).

A "route" is an interpretation of the relations between maps, and between maps and other components of a hypermedia. It discriminate the use of the relation rather than the relation itself. These new routes change the requisites at the basis of a hypertext system, as well as those normally regarded as valid for GIS. Hypertext systems are only the most evident aspect of a different manner of conceiving the use of calculating apparatus to produce new knowledge. They are therefore destined to interact with a large number of generalized software if they have to be the technological basis for a new literature. At the same time computational-oriented systems must be redesigned to allow fruitful interaction with a literary sphere now irremediably changed. As regard as the last option, i.e. the use of a OHMS, in our interpretation of the term "open" both computational and display-oriented systems should be modified to communicate among them through a common protocol. On the other hand, it is commonly believed that the computational ability is one of the requirements of a OHMS [Wiil & Leggett 96]. In this way, these approaches follow the first option as well, i.e. expanding HT systems to include computational aspects. We therefore chose to extend the functions of a commercially available hypertext system by adding primitives to it in order to handle maps, rather than adding hypertext functions to a commercially available GIS. We are convinced, in fact, that a GIS capable of performing hypertext functions has little similarity with the current standard of these systems.

In the paper, section 1 discusses some of the problems involved in the construction of geographic interfaces in a hypermedia environment, and section 2 presents some examples of interfaces developed in our prototypes. The other sections of the complete paper are on the CD-version of the proceedings.

1. The potential roles of geographical maps in a hypertext

A geographical map in a HT can potentially perform several roles, and a HT system which incorporates primitives for the geographic representation of maps must furnish primitive functions for these various roles. If one considers a map to be an aggregate object called ***map*** which can be visualized in a more general object called ***atlas page***, then the object ***atlas*** composed of ***atlas pages*** must be able to perform one or more roles. This entails that a map must behave differently according to the role that a reader and/or author attributes to it. For the sake of simplicity, we may distinguish between nodes that describe geo-referenced entities (**GRE**), and nodes that instead provide a graphical representation of geographical space and which we simply call **Maps**. There is, moreover, a third class of nodes which represent the statistical features of the **GRE**s in aggregate form. These nodes we shall call **Indices**.

Since a geographical map is a well-known approach to spatial phenomena, it comes as no surprise that many hypertexts have adopted this metaphor to facilitate navigation. One of the first applications was the Glasgow Online project [Baird & Percival 89], which used the map of the city of Glasgow to provide access to tourist information. But geographical metaphors are also to be found in 'historical' hypertexts in the broad sense which make frequent use of maps as navigation devices and/or for the dynamic visualization of historical phenomena.

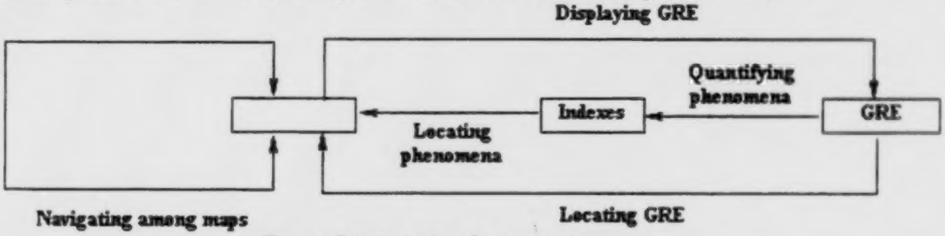


Figure 1 Principal roles of a map in a hypertext

Despite these points of 'metaphorical' contact, the convergence between **GIS** and **HTS** has not gone much beyond the use of maps as access to geo-referenced data in **HTS,** and the use of technologies based on the concept of 'object' in the construction of GIS (a necessary but not sufficient condition for the handling of multimedia data). The principal roles of a map in a HT are set out in [Fig.1], which shows the principal navigation routes between geographical entities and maps. The diagram will serve as a guide for the argument developed in this section.

1.1. Navigating among maps

If a system of electronic maps is available, it is relatively simple to construct functions which make it possible to navigate among them. Navigation within a system of maps can take place in many ways, but three of them seem to be of principal importance: moving along compass routes, changing the scale, changing the projection. We shall briefly discuss the first two, since the third is less frequently used.

1.1.1. Moving along a compass card.

To obtain this result, actions in the interface must be interpreted as requests to move in a geographical space. If the geographical space has been quantized into a finite set of maps, each of which is a node of the hypertext, and if a network of links consisting of circular lists like those shown in [Fig.2] is constructed among these maps, then movement along one of the eight principal compass directions is relatively easily achieved with commercially available HT systems. The structure of the links shown in [Fig.3] allows the implementation of what [Van Dyke Parunak 89] calls a "direction navigational strategy". The resulting topology of the links among different parts of a map is a ordered hypercube. Navigation among fragments of maps comes about by interpreting movements of the cursor {up, up_right, right, down_right, down, down_left, left, up_left} as requests to move to fragments of the map located respectively to the {north, north_east, east, south_east, south, south_west, west, north_west}.

1.1.2. Changing the scale

In many situations a request is made to pass from one map to another one of greater or lesser detail. For example, on a hypermedia interface showing aggregate statistics at a national, regional, provincial and municipal level, a hierarchical path must be constructed which enables easy passage from a map in which space is divided into countries to another map in which a country's territory is shown as the aggregate of regions, and so on. To perform these actions, it is possible to interpret a click on the left mouse button as a request to move to a level of greater detail, or alternatively a click on the right button as a request to shift to a broader geographical context. In both cases what is being requested is a change of scale with the relative increase/decrease of detail.

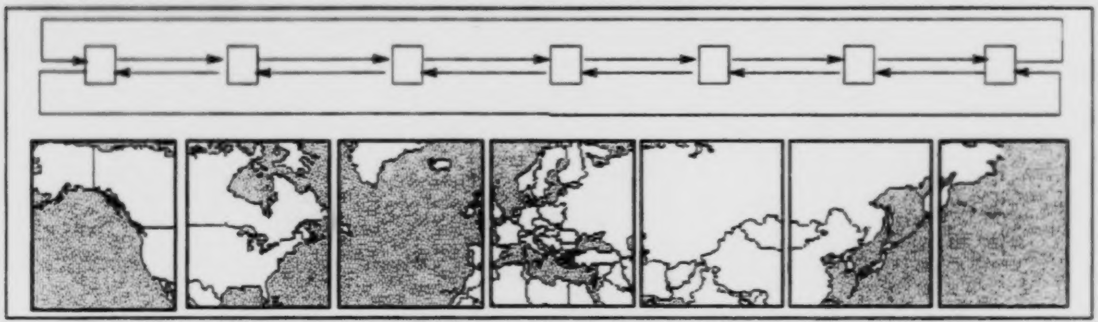


Figure 2 East and West routes along parallel directions (above) with corresponding geographic sub-part (below)

However, performing this kind of navigation with currently available hypertext systems is difficult. In order to change the scale, in fact, it is necessary to redesign the objects that constitute the map, recalculating the positions of all the vertices of the elementary objects, and hypertext systems do not possess sufficient calculation capacity to do this. Moreover, as said, a change of scale also involves the concealment or display of details. In navigation systems such as that described, disorientation may be provoked by loss of context (especially with highly detailed maps). For this reason, the automatic iconization of contexts is advisable.

1.2. Maps as indices for direct access to hypertext fragments

This is the usual way in which maps are handled in hypertexts. In this case, a map is a special fragment in which map symbols (dots, lines, regions) act as points of access to other fragments of the hypertext. Clicking the left mouse button on one component of the map is interpreted by the interface as a request to move from a geographical fragment to a non-geographical one. Thus maps can be used to construct a graphical index where a geographical entity corresponds metaphorically to an entry in an index of non-geographical fragments. As will be discussed in more detail in section [Extending the concept of geographical entity selection: an example], if a system of maps is used as an index for a collection of geo-referenced data, then the navigation actions and choices among maps can be interpreted as selections from the collection of geo-referenced data.

1.3. Maps as instruments for the visualization of the spatial location of events

The relationship between the geographical representations constituting an electronic map on the one hand, and heterogeneous fragments of data on the other, can also be investigated in the reverse direction. If while using a generic non-geographical fragment one comes across a toponymical reference, or a reference that can be made to correspond to a toponomastic reference, a hypertext should permit the visualization of the corresponding map. This is apparently trivial: if we assume for simplicity's sake that the toponym is a string of text, then activating the link defined on the toponym is equivalent to a request to jump to the geographical fragment whose name is equivalent to the toponym string.

On closer examination, however, the question is more complex. Alfred Korzybski [Korzbysky 41] warns us that: "A map is not the territory and the name is not the thing designated". For example, to what map must one jump when the link associated with the string '*Mediterranean*' is activated? Consider the following alternatives: (a)pass to the political map showing the borders of all countries with coastlines on the Mediterranean; (b) pass to a nautical map of the Mediterranean; (c) pass to a map showing the spatial extension of climate defined 'Mediterranean' in the Mediterranean basin; (d) ecc.

The question complicates further if maps have a historical dimension. For example, the string 'land of Otranto' does not designate the present-day geographical extension of the town of Otranto (Lecce, Italy).

1.4. Maps as instruments for the visualization of phenomena

All maps are thematic maps. From a technical point of view, a map is the representation of one or more themes on a reference system. Some of these themes can be considered basic (the boundaries of administrative units, orography, the road network, etc.) and can therefore be somehow preconstructed on a geographical interface, thereby creating what in jargon is called a 'white map'. A white map is nothing but a map in black and white - that is, a device on which different colours can be used to express the geographical extension of a particular phenomenon. This process gives rise to a new map with a new theme. For example, a geologist, on completion of his survey of a portion of territory, can compile a geological map using different colours for the different portions of territory on which particular rock formations are to be found. In an automatic processing environment, when collections of geo-referenced data are available, it is possible to produce thematic maps automatically - but under certain minimal conditions: (a) - the elementary components of a geographical representation (lines, polygons, dots) must be directly addressable; (b) the record of the values of the phenomenon to be described by a thematic map must be geo-referenced; (c) there must be a 1:1 cardinality relation between the graphic objects that constitute the map and the records; (d) there must be a finite collection of logical forms like those represented by the following threefold expression: <value_threshold α, value_threshold β, indicator_visual x>. Where **threshold value α** and **_threshold value β** are two numerical values which define an interval, and **_indicator_visual** x identifies a graphic sign, for example a colour. Verification of the formula value_indicator J **Between** [value_threshold α, value_threshold β] for all the records of a database enables a new map to be drawn.

A hypertext intended to be 'open' to readers must allow them to construct their own thematic maps starting from portions of archives containing base statistical indicators. Moreover, this approach is computationally more economical than the storage of numerous thematic maps as preconstructed images.

2 The topological relations among geographical entities

Since in a hypertext system the intention is to use primitives in order to interact dynamically with the maps, a model of the topological relations among the base geographical entities is needed. While developing our prototypes, we experimented with a model of the relations among geographical entities set out in [Egenhofer et al. 91]. This model will only be briefly summarized here, and the interested reader is referred to the original texts [Egenhofer et al. 89],[Egenhofer et al 93], [Egenhofer et al 94].

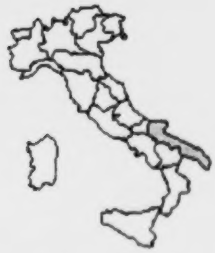
A topological relation between two geographical entities can be defined as a relation that establishes a connection between the two entities on the basis of their respective geometrical properties. In this model, the formal definitions of the objects (entities) and their relations are based on the point-set approach, where the entities are the sets and the points are components of these sets. The subjects of the relations are the points, lines and regions commonly used in GIS, and the topological space is R**2. All types of entity are closed sets (therefore every entity contains all its points of accumulation) and they are coherent - that is, they are not the union of two separate entities. A primitive function DIM(S) is constructed where S is a set of points. When this function is applied to a set of points, it restores the size of the set. If the set is composed of entities of different sizes, the maximum size is restored. DIM(S) coincides with the empty set if S is empty; DIM(S) is 0 if S contains at least one point but no lines and no regions. DIM(S) is 1 if S contains at least one line but no regions; DIM(S) is 2 if S contains at least one region. On this basis two further functions are defined: the primitive BORDER(S) and INNER(S). By compounding these two primitive functions it is possible to classify the relations among geographical entities. This classification is based on the four possible intersections between the primitives BORDER(S) and INNER(S). Not all the theoretically possible relations are meaningful: some of them, in fact, yield an empty set. For example, in the case of two regions the effectively possible relations are six in number: disjunction, inclusion, tangency, equality, coverage and superimposition. [Tab 1] gives the results for all the other possible relations. In conclusion, Egenhofer's model envisages the construction of five primitives for the purpose of investigating the relations between two geographical entities whatever, i.e. the primitives: touch; disjoint; in; cross; overlap.

Entity	Entity	N. of possible relations
Region	Region	6
Region	Line	17
Region	Point	3
Line	Line	18
Line	Point	3
Point	Point	2

Table 1

2.1 Extending the concept of geographical entity selection: an example

In this section we shall provide an example of functions constructed in our prototypes following the adoption of an abstract model of the geographical objects in the interface space. In particular, we shall show the effect on navigation of extending the concept of choosing an object on the interface. If a map is associated with a table of data, then the operation of selecting an element of the map can be interpreted as selecting from the table of data: see for, example, [Fig.3a] [Fig.3b] [Fig.3c]. Selection of a geographical object is a function that can be simply obtained by associating it with a state of the map and with an action using the mouse. Possible actions are generally of two types. The first type comprises 'point & click' actions which consist in pointing the mouse at a theme and clicking. This type of action is usually performed when the user wishes to select individual objects. If several objects are to be selected, other actions must be added to the sequence, for example making a click while pressing one of the keys on the keyboard.



SELECT *
FROM GRE
WHERE Region="Puglie"

GRE				
Region	α	β	....	δ
Puglie	...	...	...	...
Puglie	....	....	....	....
Puglie	...	...	...	...
Puglie	...	...	...	...

Figure3a The selection on the map Figure3b The coryspondent query Figure3c The resulting table

The second type of action consists in the activation of a sort of virtual window. Clicking on a point on the screen activates the window, and until the next click every movement of the mouse changes the border of the window. Once the virtual window has been fixed by the second click, it is transformed into an elastic structure which forms only around objects wholly contained within the window, and these constitute the selection made. This type of action is usually performed when one wishes to rapidly select several contiguous objects.

However simple it may be to perform the selection operation on the interface, it becomes a very powerful operator on the basis of data associated with the interface's geographical objects [Guting et al.93]. In the DBMS back-end space, in fact, it is interpretable as a selection of all the records of non-geographical data whose identifier corresponds to the identifier of the objects selected on the graphical interface. For example, suppose that we are navigating among maps until we reach the fragment containing the map of southern Italy in 79 BC and then select the city of Pompeii. A selection on the interface may correspond to selecting all the records regarding objects excavated at Pompeii. Note that, as said, also the operation of navigating among the maps can be interpreted as a dynamic selection among the records of the data base. In fact, choosing the map of southern Italy entails selecting all the rows concerning archeological findings in southern Italy; choosing the map for 79 BC restricts the search to those dating to 79 BC.

If primitives are implemented which are able to calculate the status of the topological relations among the graphical objects representing geographical entities on the interface, the selection operations performable on the interface can easily be extended. In our prototypes, in fact, virtual window-type selection actions were modified by adding two new forms of selection, called *partial selection* and *external selection*. In partial selection all the objects covered by the virtual window are selected, even if they do not lie wholly within it.

In external selection, instead, all the objects lying outside the virtual window are selected. As regards implementation, partial selection is obtained by verifying which geographical entities respond positively to the primitive 'in' or to the primitive 'cross' with the region represented by the virtual window. In external selection, the primitive used is instead 'disjoint'. Also these actions are interpretable in the back-end as queries to the database

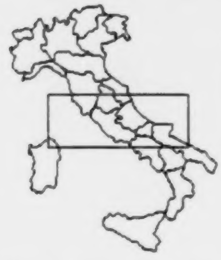


Figure 4a Selection windows

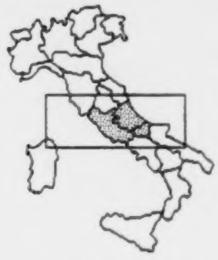


Figure 4b Inner selection

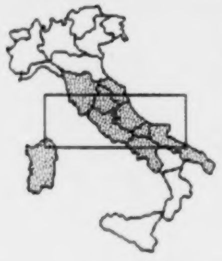


Figure 4c Partial Selection

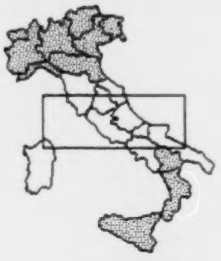


Figure 4d External Selection

. In the above example, the external selection amounts to selecting all the records concerning archaeological discoveries in southern Italy datable to 79 BC but not found at Pompeii, while partial selection can be used to select objects found in adjoining areas as well.

Once the selection method has been chosen, the reader uses the virtual window. The action of fixing the borders of the window sends a query to the back-end primitives, which calculate the topological relations among the objects present on the map and the coordinates of the virtual window. The result of this calculation is a list of objects that satisfy the topological relation and that is used by the front-end to evidence the result. Simultaneously, the list of values identifying the objects selected can be used as a condition in OR to trigger a new back-end process consisting in the selection of occurrences from the database. Referring to [Fig.4], in which all the Italian regions are stored in a database with their names, the three selection operations are expressed by the following simple SQL queries.

Inner Selection

SELECT * **FROM** GRE **WHERE** Region="Lazio" OR "Abruzzo" OR "Molise"

Partial Selection

SELECT * FROM GRE **WHERE** Region="Tuscania" OR "Lazio" OR "Abruzzo" OR "Molise" OR "Umbria" OR "Marche" OR "Campania" OR "Puglie" OR "Sardinia"

External Selection

SELECT * FROM GRE **WHERE** Region NOT = ("Tuscania" AND "Lazio" AND "Abruzzo" AND "Molise" AND "Umbria" AND "Marche" AND "Campania" AND "Puglie" AND "Sardinia")

The opportunity offered by the data model of calculating topological relations among geometric representations enables actions to be performed in the interface to obtain objects of different degrees of abstractness. In fact, the relations can be calculated on the basis of only one of the graphical objects that make up a map. In other words, once an object has been selected, all the other objects that stand in a specific relation to it can be straightforwardly obtained. In some cases, the set obtained has a specific meaning that depends on the specialization of the geometric entities considered. For instance, if the calculation is restricted only to river-lines (i.e. the broken lines that represent rivers), once the river Colorado has been selected, it is easy to show its tributaries. In fact the Colorado's tributaries are all and only the river-lines tangential on a single point with the line identified by "Colorado". The calculation can be performed recursively with all the tributaries of the Colorado until all the watercourses that constitute the Colorado basin have been evidenced. In this case, 'basin' is an abstract entity obtained as an aggregation, on the condition that all the component lines are directly or indirectly tributaries of a generic river.

3. Conclusions.

From our experiments with hypertexts, we are convinced that it is necessary to reconsider the technology employed to handle geographical data. The development of hypertext applications for large corpora of information means that extending HTS performance becomes increasingly urgent. In other words, the ability of these systems to connect heterogeneous data fragments together also highlights their limitations. We believe that much work will have to be done in the future if HT systems are to become efficient devices for the production of cultural artifacts. If this does not happen, the great potential of these technologies will be frustrated. The outcome will be, not the progress of knowledge, but its trivialization as evidenced by so many of the products currently on the market.

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Student CD-ROM Portfolios

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Abstract: The paper describes the diffusion of an innovation, CD-ROM portfolios, into the curriculum of a laptop university over a six year period. A Title III Grant provides the money for the project. During the completion of each student's degree requirements, the student saves projects which demonstrate the abilities expected by the university. Prior to graduation, each student organizes the portfolio and burns a CD-ROM for use by prospective employers. The process of diffusion is discussed as well as hardware and software choices. An example of a Music Education project to be used as part of the portfolio is included.

Project Background

Valley City State University is a campus of about 1,000 students. Eighty percent of its students major in Education or Business. It became a notebook computer campus in the Fall of 1996 when all full-time students were issued notebooks upon registration. The faculty received their notebooks and appropriate training in February of 1996. These realities make the ambitiousness of the CD-ROM Portfolio project more lucid.

The project, to use portfolio assessment as a tool in the Valley City State University Curricula and from it allow students to create CD-ROM portfolios prior to graduation, became visible on the campus in November of 1995 with the hiring of a Director of Instructional Technology. The following two months were spent orientating the campus to the project as well as remodeling the multimedia area for the project and planning for the purchase of appropriate equipment. Presentations concerning the grant were made to all entities at the university including staff, administration, faculty, and the Portfolio Learning Team. (the Learning Team consisted of 10 faculty and 14 students who volunteered to learn about the CD-ROM creation and then mentor a peer in the Fall of 96) The Director received training during this period on the architecture of Windows 95 and in-depth training on the operating system since this would be the operating system in the multimedia lab.

During the first two months of the new year final equipment decisions were made, bids were taken from venders and leasing companies were contacted. The hardware for the Portfolio multimedia lab was obtained on a capital lease over three years. Through the leasing process the equipment money authorized in the grant for the first three years could be put to use in the first year. The lab consisted of five multimedia stations.

Also during this period all faculty were issued notebook computers in preparation for Fall 96 semester when all members of the student body would also receive a notebook computer upon registration. Immediate training for the faculty began concerning the care and management, the hardware, the software and the communication systems available with the notebook. Special training for the Portfolio Learning Team on the advanced PowerPoint skills was also completed. This was needed because the plan, at least initially, is to use PowerPoint as the authoring software for the CD-ROM Portfolios. Although PowerPoint has weaknesses as an authoring software, its strengths are its availability to all faculty and students on the campus, its existence on both PC and Mac platforms and its uses in other types of academic projects.

The Learning Team, composed of ten faculty members was expanded to include fourteen students. Learning Team meetings focused on portfolio use in the classroom setting. Faculty on campus who had used portfolio assessment were invited to join the discussions. Outside consultants were considered and contacted for future contributions. Finally, a three ring binder was created for each Learning Team member containing information on portfolio issues and on each of the necessary softwares. The material in the binder was used as a resource, and in the mentoring process for the Fall 96 Learning Team.

During the final months of the 1996 school year, March-May, the Learning Team's discussions focused on internalizing the use of portfolios as part of the curriculum. The process began with discussions of the newly established foundation studies abilities. The portfolio process is seen as a way of allowing students to show competence levels in the eight abilities identified. The Learning Team also conducted discussions with K-12 administrators and business executives concerning the use of the CD-ROM by future employers of Valley City State graduates.

Also during these months the campus network was completed and remodeling of 16 multimedia rooms was planned. These rooms include hardware for computer and video projection as well as network, intranet, Internet and electrical connections for student computers. The Title III room remodeling was completed, the new equipment arrived and was prepared for use.

Faculty/student Learning Team members received training in each of the skills needed to create a CD-ROM portfolio. Each training included a "How To" resource sheet for inclusion in the Learning Team binders. Each Team member completed a project showcasing the skills acquired during the training sessions. Summer stipend projects were outlined by each faculty Team member

Prior to the end of the Spring semester, new learning team members for Fall semester were identified and a rough draft of a plan for informing the freshman class about portfolio expectation was completed. A meeting was held with the Chairs of all of the academic divisions on the campus. At the meeting a flow chart [Fig. I], created by the Learning Team, for internalizing the (CD-ROM) Portfolio concept into the curriculum over the next four years was discussed.

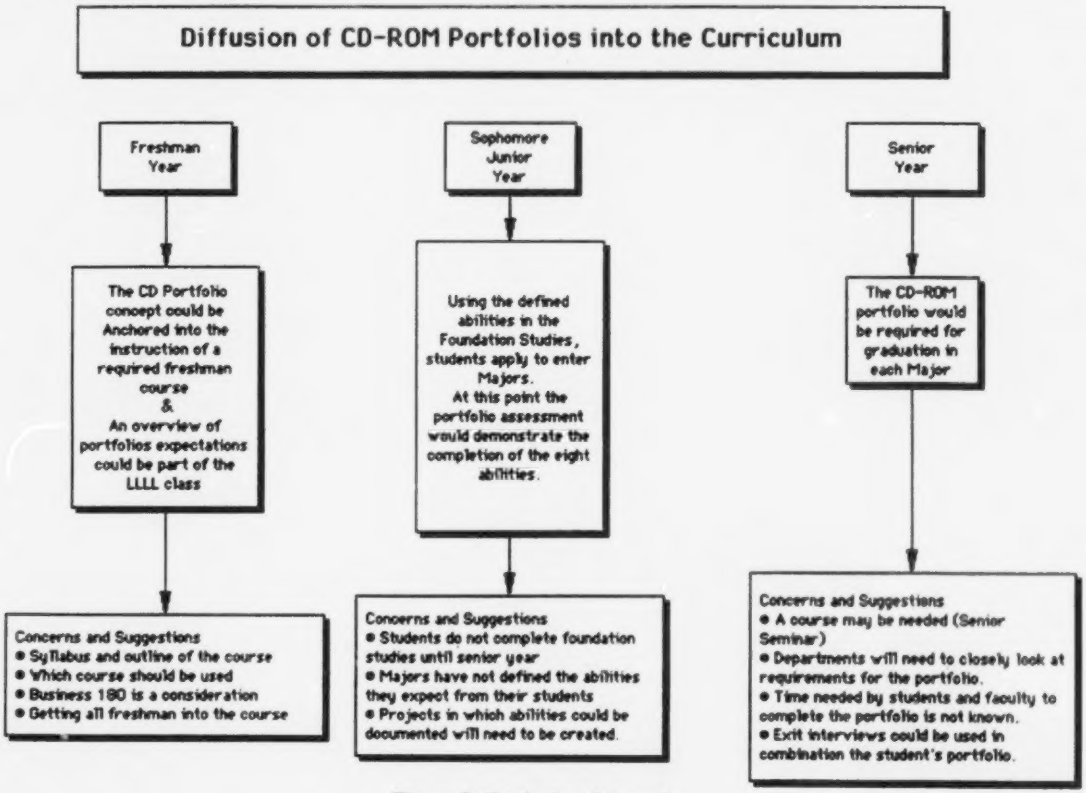
Diffusion of CD-ROM Portfolios into the Curriculum
Freshman Year
Sophomore Junior Year
Senior Year
The CD Portfolio concept could be Anchored into the instruction of a required freshman course & An overview of portfolios expectations could be part of the LLLL class
Using the defined abilities in the Foundation Studies, students apply to enter Majors. At this point the portfolio assessment would demonstrate the completion of the eight abilities.
The CD-ROM portfolio would be required for graduation in each Major
Concerns and Suggestions
• Syllabus and outline of the course
• Which course should be used
• Business 180 is a consideration
• Getting all freshman into the course
Concerns and Suggestions
• Students do not complete foundation studies until senior year
• Majors have not defined the abilities they expect from their students
• Projects in which abilities could be documented will need to be created.
Concerns and Suggestions
• A course may be needed (Senior Seminar)
• Departments will need to closely look at requirements for the portfolio.
• Time needed by students and faculty to complete the portfolio is not known.
• Exit interviews could be used in combination the student's portfolio.

Figure I: Curriculum Integration

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A priority during the summer months was to make graphic recording of events more available to the campus in general. Toward this end, several pieces of graphic recording hardware were purchased (digital camera, Snappy and Quickcam). These are available for faculty and student check out. Also a Polaroid Educational Workshop is scheduled for the coming school year. This workshop gives a Polaroid camera to each participant.

During the week prior to the 96-97 contract year optional workshops for faculty were held. They included PowerPoint, Web Page Development, Use of Network, and Groupwise E-mail. Faculty in-service included sessions on Portfolio use in the classroom and an overview of database software to be used in tracking the abilities required as part of the CD-ROM portfolios.

By September 30th Summer projects will be completed and given to the Title III Director. Each will be accompanied by a written summary and digital results where applicable. One of the summer projects involved the creating of a Digital Template for the portfolio. That template will be used to complete the first sample portfolio on CD-ROM. It is also being used as part of a presentation to each Freshman orientation group on campus.

Priority I: Integrating Portfolios into the Curriculum

The use of the hardware and software to created the portfolios is certainly a concern, however, integration the portfolio concept into the students four year education created a larger road block. The visual form [Fig. I], explains the expectations developed by the Learning Team during its first year of existence. The plan includes:

1. exposing freshmen to the CD-ROM portfolio concept new student orientation courses during the first few weeks of their freshman year.

2. using the portfolio concept as an anchor for the software in a freshman level technology course

3. creating a portfolio at the completion of Foundation Studies courses. It is to be presented to faculty in the student's major curricular area the. This portfolio will illustrate the student's level of ability in each of the eight objectives.

4. Divisions/Departments requiring a completed portfolio as a graduation requirement for the major area. The portfolio may be tied to a course or an exit interview.

Priority II: Ability Based Foundation Studies

Since 1993 Valley City State has begun to rethink the foundation studies objectives. The new direction included, expressing objectives in a more measurable form, stating clearly the expectations connected to the objectives and a clear understanding of the student expectations connected with the objectives. The portfolio would be central to involving the student in the assessment of the process. It also allows for a very visible format in which the student can show growth.

The result of these changes is a list of eight abilities which reflect the Foundation Studies objectives in a more assessable format. The abilities follow.

Communication
Effective Citizenship
Aesthetic Responsiveness
Technology
Problem Solving and Decision Making
Collaboration
Global Perspective
Wellness

Closely tied to Valley City State's expectations concerning the recording of student ability levels and the creating portfolios is the notebook initiative. Every full time student and faculty member on the campus has an IBM Think Pad. The notebooks allow student to create and save materials on there own hard drive. The campus network also allows for fairly simple movement of large files from computer to computer. Both, make the saving of materials and creation of the CD feasible for a large number of students. The graphic [Fig. II] is a visual representation of the strategy.

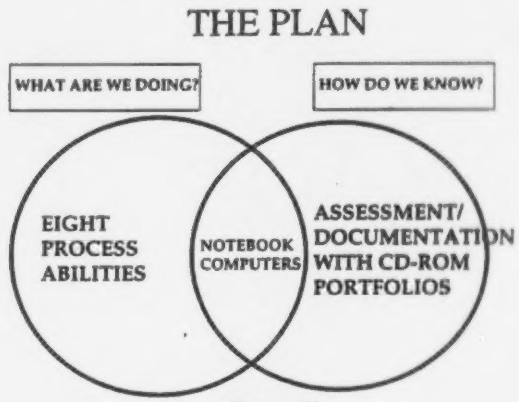

Figure II

The integration of the portfolio concept on the campus involves a faculty/student Learning Team.. An effort was also made to use experience and expertise concerning portfolios which already existed on the campus. Faculty development funds were used to encourage individuals to share such expertise. One such workshop by a faculty member spawn the following portfolio projects by faculty in several divisions.

- Physical Education - Developed a five to ten minute videotape on a first aid skill. Student groups created the video tapes. Portions of the tape will be digitized and used to show the students proficiency in the first aid skill.

- Elementary Education - Students developed personal class portfolios using the software PowerPoint. The portfolio will demonstrate what was learned by the student during the course.

- Humanities (Visual Art Component) - The class is producing projects in which the students are making mock presentations to museum boards. The presentation asks the Board to consider a painting for possible acquisition. Each student group then makes a presentation illustrating what they have learned and this is videotaped.

Background of the Student Portfolio Project

This pilot project for interdisciplinary teaching among the public school fine arts departments, the Valley City State University (VCSU) music department, and the Valley City community began in the spring of 1996 when all the cooperating institutions gathered representatives to write a grant to US West for the funding of a dream. The dream was to create a project based in real life which would allow young people opportunities to work together to create original opera. The theme chosen for the project was "Coming of Age in Valley City" with the aid of the institutions working cooperatively together. The dream was to have eighth grade students write lyrics, compose music, create artwork, and produce an original opera which was completely student-driven. In order for these young students to produce such a large project, technology and mentoring from older students and adults was included in the plan. "Coming of age" also meant discovering the senior citizens in our community and thus they were also included through an ongoing federally funded program called SAGA (Spanning Age Groups with Artifacts).

The grant was won in mid September, 1996 for $16,000.00. The original budget was $80,000, so many of the needs were not met. However, our priority was a six workstation lab which was put in place in the junior high school. Each workstation had a PowerMac 5260 with CD ROM drives, 8mg RAM, and 500 mg hard drives.

The Yamaha PSR320 electronic piano was chosen for its price and flexibility. Each keyboard is equipped with a dual headphone system so that two students can work together. The onboard sequencer/recorder allowed many students the ability to experiment and capture their sounds without having to remember everything they did. This information was then dumped into the notation software, Overture. The students could then edit their work and produce almost music publisher quality "sheet music." The keyboards and computers were connected with Altech MIDI (Musical Instrument Digital Interface) translators and 5-pin MIDI cables. In addition, all of the computers were networked with Appletalk to a laser printer. Finally, one workstation was designed as a teacher presentation station in a Wenger cabinet which was connected to a Zenith TV monitor. Future plans for the lab include a Yamaha Clavinova (or several) and a piano lab networked teacher station which will allow students to be grouped, allow for the teacher to listen in on the work in progress, and provide a communication system among the students in the lab.

Valley City Public School shares two music teachers with VCSU and has served as a "lab school" for the pre-service teachers being trained at the university. This project allowed for two VCSU music students to earn a stipend of $150.00 per semester (essentially paying the expense of the course) and one credit per semester as they worked with the eighth graders. The class was titled Music Technology Internship in the Junior High School. The course provided for two semesters of mentoring and teaching for two hours per week. The college students were trained on the software and hardware and had practice sessions on composition activities during the first few weeks of the semester. The MIDI lab was put in place in late September with training sessions for the eighth graders beginning the following week. Following an orientation period, the VCSU students led activities in composition which eventually became the basis for the songs used in the opera. The two institutions also share an art teacher who worked with students to prepare the backdrops for the opera. The art department also worked with SAGA to produce a mural based upon old photographs of Valley City which was painted on the side of the administration building which stands on Central Avenue.

As the VCSU music students worked with the eighth graders, they collected various pieces of materials which would document their work in progress. These materials were collected as video, audio, MIDI files, word processed documents describing their work, lesson plans, etc. The materials were gathered into the portfolio which you will see on the CD ROM which was produced as a result.

Student Learning Goals as Described in the Grant.

Eighth Graders

1. Interdisciplinary. Students will understand the relationship between literature, music, and the visual arts. Students will learn to work cooperatively with their classmates, with their instructors, with college students, and with community volunteers to produce an interdisciplinary performance around a chosen theme.

2. Technology. Students will learn to use technology to enhance the creative process in writing, music composition, art, and presentation.

3. English. Students will learn the elements of a short story and drama and use these elements to write a script. Students will learn to write dialogue and how motivation plays a major part in the dialogue. Students will learn stage presentation, blocking, and vocal projection.

4. Music. Students will compose short pieces within specified guidelines, using MIDI technology, assisted by college music education students. Students will demonstrate an understanding of how music enhances the plot and dialogue in the lyrical theater.

5. Visual arts. Students will learn how to design and paint a large mural. Students will learn to document the process using digital cameras. Students will learn to design a set for the music production using slide projectors to present a documentary visual display.

College Students

1. Students will learn basic music technology skills such as setting up and operating the MIDI stations. Students will design lessons on MIDI and practice their teaching skills teaching eighth graders. Students will utilize different strategies in aiding the creative process of composition, providing guidance in successful harmonizations, and teach mini-lessons on tune-building, i.e., sequence, repetition, and intervals.

2. Students will develop a Compact Disk, using the electronic portfolio development process being piloted at VCSU, containing footage and descriptions of their experience working with junior high students for their professional portfolio.

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Integration of Multidatabase Technology with Multimedia Application Authoring Tools

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Abstract: As the complexities of multimedia applications increase, large amounts of media data are required for each application. A case is made for the inclusion of database support in application authoring environments to aid both media management and access. A virtual database model is proposed and implemented for the AthenaMuse2™ application authoring tool. The virtual database provides the author with a standard object-oriented interface to all the major types of database system. The virtual database is responsible for all data model translation issues that arise. A variety of example applications are described which emphasize the flexibility and usefulness of the model. Extensions to the model, for example application object storage, are proposed.

1 Introduction

Improvements in storage technologies and processing speeds have led to the development of a new generation of multimedia educational and entertainment software, where each application may incorporate thousands of different media elements such as text, images, audio, video and graphics. The majority of software development tools force the application author to encode the media either directly (for example, by typing in the text to be displayed) or indirectly by specifying the file name of the media that is to be displayed. This process has two distinct disadvantages. First, performing modifications to the data requires access to the authoring tool, putting such capabilities beyond the reach of the user. Even if the external data files are accessible, there is no easy way to identify which data element can be found in which file. Second, using only the file system to keep track of a large number of media elements during the application development process becomes very cumbersome. Finding the name of a file corresponding to a particular piece of data can involve searching through large amounts of application code and accidentally moving or deleting a file will result in a broken application. Development environments which incorporate tools for managing and searching media are needed.

The addition of database facilities to the authoring environment provides a centralized mechanism through which data can be stored, accessed, modified and deleted in an orderly fashion. A database access language can be used to specify data independently of the file system and other environment variables. Media objects can be modified in the database and these modifications realized in the application, without altering the application code. Database systems are specifically designed for tasks such as data entry, deletion or modification and provide appropriate interfaces for these functions. Once all data belonging to a particular application is stored in a centralized location, such as a database, it becomes much simpler to protect against accidental deletion and to move or copy the data as a single unit. Database systems can provide extensive facilities for data searching and querying that would not normally be available to an application. If selective data is required by an application it can be stored in the database and a simple data query used to retrieve the correct data set. The application can also be given access to preexisting legacy database systems which can significantly increase the usefulness and economic value of the application. For example, an application could connect to an existing museum catalog or digital video repository.

The critical aspect of any scheme to provide database access to authoring tool is the variety of database system types that must be supported. The application author will choose the database system for a particular application based on the features of the system (e.g. price, platform availability, multimedia support) or on the necessity to interact with one or more legacy systems. This paper describes the design and implementation of a virtual database module that can be included in an application authoring tool. The software was embedded in the

AthenaMuse 2™ multimedia authoring system developed by the MIT Center for Educational Computing Initiatives [Harward 1994].

2 The Virtual Database Module

Every database system provides its own proprietary method for communicating with an application, known as the application programming interface (API). Obviously the application author does not want to learn a new API for every database system that needs to be connected to an application [Ram 1991]. The virtual database module [Figure 1] is designed to offer a *standard* method of interfacing a wide variety of database systems. Moreover, it may be necessary for the application to connect to multiple database systems simultaneously, and the virtual database module must allow for this [Hurson 1994]. For example, an application may allow the user to selectively download data from a remote database system managed by a publisher or library to a local database residing on his or her own computer. This is the type of functionality that is needed in software that allows a student to search commercial databases for relevant information and then store the results of those searches in an electronic notebook. It is also important that the programming interface to the virtual model reflect the needs of the application author. No prior information concerning the database, other than its system type and location, should be required to establish a connection. The structure of the database (the database schema) should be retrieved automatically upon connection by the virtual database system. The application's author can then use this information about the schema to construct appropriate interfaces for the software's user.

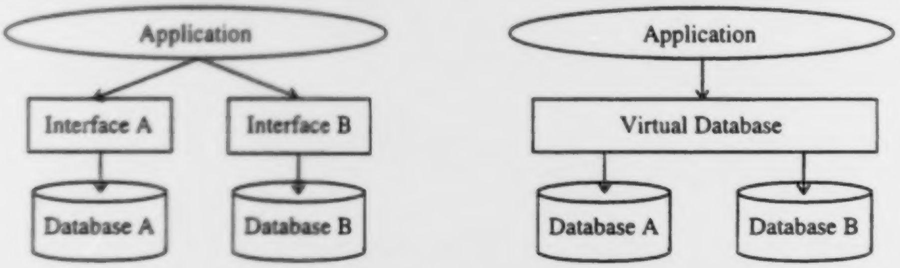

Figure 1: The virtual database provides a common interface to different database types so that the author can avoid using different APIs to connect to different databases

The Open Database Connectivity (ODBC) standard [Microsoft 1994] provides a standard API intended for use with relational database systems. The Object Database Modeling Group (ODMG)[Cattell 1995] has proposed a similar type standard for object databases. however, these standards to not address the problems faced by an application author who wishes to take advantage of both these types of database. In addition, the interfaces provided by these standards are not particularly easy to learn or use, nor do they provide all the functionality typically needed by an application author. Within the virtual database model, each standard is treated as a particular type of database system.

Since individual databases display different levels of functionality, the virtual database system must provide a flexible interface that allows access to the extended functionality of some databases while providing extra functionality to compensate for the more primitive database systems.

There were five steps in the design process of the virtual database module, each of which is summarized below. First, a standard database model was chosen for the virtual database. Second, standard data types were defined. Third, a standard query language was defined for data access. Fourth, a mapping process to transform component database systems to the virtual database model was designed and implemented. Fifth, an object-oriented user interface to the virtual database system was created.

2.1 The Virtual Data Model

The most important property of any database system is the data model upon which the system is built. The data model is a factor that critically affects every other aspect of the system. An important role for any virtual database system is to operate in an environment where multiple data models may coexist. The virtual database model must therefore be able to encompass a very wide range of pre-existing database system models [Hughes 1988].

The first widely used data models were the hierarchical and network models. Although superseded by the relational data model, these early data models are still found in legacy systems and file systems. The relational data model currently remains the most popular model for commercial database systems. The model is based on the concept of a relation: a set of ordered data tuples, such that each item in a tuple belongs to a specific data domain (e.g. integer, real, string, date)[1]. Compound data types such as lists, sequences or sets are not allowed as domain types in relational databases. This is perhaps the biggest disadvantage to the relational model. Closely tied to the relational model is the concept of data control and management languages which are provided with the model to allow the user to create, modify, delete and access data. Structured Query Language (SQL) is a widely accepted standard for a data retrieval and management language for relational database systems.

Object-oriented database systems are software systems that integrate technology from the fields of database systems and object-oriented programming languages [Bertino 1993]. The core concept of any object-oriented system is that each real world entity in the system is modeled as an object, and the resulting set of objects communicate with each other via messages. An object-oriented database system provides a means of making these objects persistent. Object-relational database systems have been developed to take advantage of the complex data types allowed in object modeling, while building on the strengths of the standardized query language and formal mathematical base of the relational model [Stonebraker 1996].

An object model was chosen for the virtual data model. It is the most advanced of the existing data models and is most capable of representing the complexities of multimedia data and hypermedia links [Booch 1994]. The flexibility of the object model enables it to capture the semantics of other data models without loss of information. One of the main features of object-orientation is the separation of interface from implementation. This allows the access protocol to the virtual database model to remain constant, while the implementation of the model varies according to the component database system involved. In this way, the incompatible internal details of component systems are kept hidden. The object model can take advantage of inheritance to define a class hierarchy that ensures the appropriate translation procedure is carried out for each of the different types of component systems. Classes can be specialized to carry out the translation process for relational database systems, and then further refined to carry out the translation for a particular relational database. The model is closely based on the object model proposed by the ODMG. In this way it is hoped that the virtual database module will itself conform to emerging object database standards.

2.2 The Virtual Data Types and Query Language

A key component of any database system is the set of fundamental data types from which class attribute and method definitions are built. An allowable data type in one of these definitions is either a fundamental data type or an existing class. The virtual database system defines a set of common data types and is then responsible for translating the fundamental types of the individual component database systems to and from the common types. The types defined for the virtual database module include simple types (e.g. integer, string), objects (e.g. date, sequence) and multimedia objects (e.g. image, sound).

The query language for the virtual database is derived from ongoing developments in SQL and the Object Query Language (OQL) standard prepared by the ODMG. Both the SQL3 [Mattos 1994] and OQL [Cattell 1994] standards are heavily based on SQL-92. These languages are both extended forms of SQL in that they implement a version of SQL that has been expanded to take advantage of the object data model. The two major extensions are to allow ***attribute path specifications*** and ***method specifications*** in queries. Attribute paths allow a query to refer to the components attributes of an object. For example, if an object of class Document contains objects of class Page, then a reference such as objDoc.page might refer to the first page of the document named objDoc. Methods are procedures which are components of objects and which can be executed on those objects. For example, a method named nextPage might fetch the next page of a document.

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[1] Relations are often referred to as tables in the database, and tuples within a relation are often referred to as rows of the table.

The common query language for the virtual database is concerned with data retrieval only. Data and schema manipulation is possible, but is done directly through operations defined on the virtual database objects, not through the query language.

2.3 Transformation from Component Databases to the Virtual Database

The next step in implementing the virtual database module is to provide a methodology for translating each component data model to and from the common model. In keeping with the object model, the database user explores a database schema by examining the database class hierarchy and the properties of individual classes within this hierarchy. The translation process is responsible for creating a class hierarchy that adequately represents a component schema. Once the class hierarchy is established, the translation process is also responsible for providing access to the data stored within the database. This data is presented to the user as object instances belonging to a particular class. Where necessary, type conversion from fundamental component data types to common data types must be carried out. All these translation operations are transparent to the user who uses the same interface to access schema information and data objects for all component systems.

One of the problems in providing translation from real-world databases to the virtual data model is that some constructs that are supported in the virtual model are not available in some component systems. For example, some component systems do not support notions such as the definition of operations on data types or database keys. In addition, many real-world database systems do not support the full range of fundamental data types allowed for in the common virtual data model. In some cases, the virtual database is able to make up for these deficiencies by providing supplemental data translation capabilities between the virtual database system and the component database. In all cases, such deficiencies must be treated gracefully and should not interfere with the operation of the virtual database module.

The translation process for an object-oriented or object-relational database is relatively straightforward and requires the least translation effort. For a relational data model, every table in the relational schema can be translated as a class in the virtual object model. The class name is taken from the table name. Each field in the table is used to represent an attribute of an object [Albert 1993]. The hierarchical data model is composed of data elements arranged in a simple tree structure. A set of data element types is defined for the database, with each type consisting of a set of data fields. In the common object model, each element type is considered to be a class, and the data fields are interpreted as attributes. As in the relational model, the type associated with each field will be translated into a fundamental type belonging to the common model. Each data element becomes an object. Small changes in the process may be necessary for individual databases, or some databases may require the combination of techniques from different categories. The translation procedures are completely automatic, although database administrators may provide extra information to be used in the translation process by inserting this information in the component database itself.

2.4 The Virtual Database User Interface

The interface to the virtual database system that is presented to the application designer, and by extension to the application user, is extremely important in determining the contribution that the virtual database can make to improving the functionality of the application. It takes the form of a set of predefined database object classes. The designer can use these classes directly, or can derive more specialized classes for database manipulation through subclassing.

The interface can be divided into two main parts. The first part is a set of classes that represent the fundamental data types available in the virtual database system, while the second part is a set of classes that represent a connection to a component database and provide operations for schema manipulation and query construction and execution. An application author uses exactly the same interface classes to connect with any database supported by the system and the author may have several open database connections simultaneously. The common interface promotes data interchange between the connections and a multidatabase interface object is envisioned which would provide supplemental multidatabase operations [Bukhres 1996].

3 Applications

A sample of the applications developed to date are described here in order to provide an indication of the diverse database systems which have successfully been used to author and run applications with the virtual database module. Examples using relational and object-relational databases will be detailed. The purpose, complexity and target audience of the applications all vary widely.

3.1 The MIT Museum Edgerton Collection

The MIT Center for Educational Computing Initiatives and the MIT Museum recently completed a project to provide electronic access to the collected works of Harold Edgerton, famous as a pioneer of strobe photography[2]. The collection was cataloged using the object-relational database UNISQL/X™, which allows for the possible specification of hundreds of data fields. The ability of UNISQL/X to model complex data structures was of immense importance to the success of the project, which would have been very difficult, if not impossible, to complete using traditional relational database systems. The object-relational database also provides better facilities for storing image data, either in the database for small thumbnail images, or as references to external files for larger images.

In addition to using the database catalog for internal bookkeeping and reference purposes, the project created an interface to the database so that a museum patron can browse Edgerton's photographs. There are over 7,000 photographs in the collection, and it would be physically impossible to display all of the photographs together at one time. By providing a patron with the ability to query the database, the patron is able to search for photographs of a particular subject that interests him or her, as well as to browse the catalog at random.

The virtual database interface within the AthenaMuse2 authoring environment was used to implement this browser application.

3.2 New England Aquarium Kiosk

The virtual database interface was also used as part of an application developed by the MIT Center for Educational Computing Initiatives in collaboration with the New England Aquarium. This software operates as a kiosk in the aquarium in an exhibit about the flora and fauna of New England Ponds. The virtual database accesses stored information about the quality of local ponds, still images about various wildlife, and records about the video, audio and still images that are used throughout the application. Users can select ponds anywhere in the local area by clicking on a map of the region, and appropriate information relevant to the nearby pond is fetched from the database and displayed.

An important advantage of this software architecture is that the information on water quality can be updated without altering the application software. Any change in the underlying database is immediately reflected in the software the next time a query involving that information is made. New images, text and other media can be added simply by altering the database.

Many other applications have been written that take advantage of the virtual database module to provide a consistent interface for both media management and media access across a variety of object, object relational and relational databases and the file system. These applications include a generic database browser and a notebook type application that highlights the simultaneous use of multiple databases. The examples quoted in this paper show that the same virtual database interface can effectively utilize the very different characteristics of the underlying database in a manner which promoted the use of databases in the authoring and execution of multimedia applications.

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[2] The Edgerton project was supported by the Edgerton Foundation and involved a large number of different individuals, including James Sheldon (Producer), Lynne Bolduc (CECI staff member), Kara Schneiderman (MIT Museum) and a number of other CECI and MIT Museum staff.

4 Extending the Virtual Database Functionality

The vast majority of applications that have been developed so far with the aid of the virtual database module., have simply used the virtual database to retrieve information that was initially stored in a database during the application authoring process. However, the virtual database also provides an excellent foundation for further research into the innovative uses for multidatabase technology within the application authoring environment. Two examples are application object storage and the dynamic evolution of applications.

A typical application can be divided into two parts, the application data and the application behavior. Until now, this paper has considered only the permanent storage of application data. A novel extension to the virtual database module has been implemented to allow the application behavior to be captured in a database, enabling the development of a new paradigm in application storage [Curtis 1996]. There are significant advantages to being able to both store and retrieve application objects from a database during the running of an application, including advances in error handling, collaborative authoring and the individual customization of application behavior depending on end user actions.

An application that is provided with a database connection can use that facility to update media data automatically [Dynes 1997]. Data updates might be stored in a centralized remote database to which the application connects occasionally. The updated data set is downloaded and inserted into the local application database. The application author can grant the application's users control over all or parts of the database so that they can modify the application.

5 Summary

The case is made for the use of databases in the development and use of multimedia applications. A virtual database module, present in the AthenaMuse2 authoring tool, is described. It provides a consistent programming interface for differing types of databases. Examples were detailed where this virtual database interface was used with object-relational and relational databases. The utility of databases in both the authoring and execution of multimedia applications has given rise to suggestions for innovative authoring styles. The virtual database module can be used to store application objects or to enable the dynamic evolution of applications.

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"The Development Of A Dynamic, Contextual Application For Enhancing Learning Through User-Driven Authoring Using The Internet."

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Abstract: This paper is an overview of the design, development and implementation of an Internet-based application, *CyberRecess*^{TM}, designed for children from kindergarten to grade 12 (K-12) in which the setting of a particular context is used as the basis for the creation of dynamic, user-driven content. It attempts to integrate current learning theory and technology in its creation. The product is designed to maximize the contextual relevance to the learner through combining user-authored content with the communication abilities that the Internet makes possible. Using a learner-centred model and constructivist principles, we set out to create an application that empowers and challenges the student to engage in active learning. By virtue of a networked, interactive multimedia learning becomes location-independent and self-directed. Contextual relevance and dynamic content is automatically created through empowering students to author their own content.

Introduction

We are in the midst of a digital revolution that promises profound change in the way we work and learn. Enabled by technology, these changes result not only in new learning concepts, but ultimately in systemic and cultural changes in our educational institutions. The challenge for creators of learning multimedia applications has been to create applications that integrate learning theory with the effective use of technologies that are rapidly changing. The key to enhancing learning through the development of new applications is the creation of tools which are intuitive, relevant and that assist in the creation of environments that facilitate both the communicative and community aspects that are so essential to the learning process. Networked Interactive Multimedia (NIM) technologies such as the Internet and World Wide Web allow users to communicate with others on a global scale easily and effortlessly. Combining learning theory with these technological capabilities results in applications in which user-driven interactivity forms an essential part of this process.

Learning Theory

Learning is the acquisition of knowledge through study, experience, or instruction. Critical to this process is the use of high-level communication, demonstrated by shared ideas, critical thinking, debate and discussion. Current theories of learning and knowledge-building are evolving rapidly. Modern theories of constructivism suggest that knowledge is not merely a passive transfer between teacher and student, but is actively constructed by the learner. Recent research [Kafai & Resnik, 1996] investigating the use of technology in learning pioneered by Seymour Papert at the Massachusetts Institute of Technology suggests that when students are actively engaged in making some type of artifact that they can reflect upon and share with others, they are more likely to create new ideas. Central to this theory of "constructionism" is the notion that, in the learning process, the affective is as important as the cognitive - that is, forming new relationships with knowledge is as important as forming new representations of knowledge.

Another key element of constructionism is diversity. The recognition that learners have multiple learning styles and make associations and connections with knowledge in many different ways is revolutionizing our concepts of learning. Gardner's theory of multiple intelligences [Gardner, 1993] asserts that we each have separate human capacities. This is accelerating the focus on "individual-centered education". Finally, context is essential to the clarification and development of meaning. Communication of ideas and the sharing of knowledge with others in a community of learners also play key roles in the development of context.

Technology

Against this backdrop of learning theories, we have technologies that are revolutionizing our world but, to date, have had little or no influence in the classroom and in the ways our children learn. Traditional computed-based instruction (CBI) has tended to be "programmed heavy" and, while allowing for some interactivity, was designed essentially as an extension of extant pedagogical methodologies. That is, the user merely followed the course of study according to a programmed path and is not easily able to deviate from it. Most CD-ROM courseware follows this type of "structured interactivity".

The learning benefits of CD-ROM based, multimedia learning applications can be substantial and have been well documented over the years. However, there remain several inherent limitations to these applications:

1. These applications are designed using a paradigm that does not utilize the capabilities of the technology. Networked interactive multimedia (NIM) and, more specifically, the Internet allow for applications that are learner-centred and discovery-based.

2. Communication and collaborative learning with peers does not occur as part of the process. CBI tends to be isolationist with one student working on a standalone basis. The focus is on information and analysis without any communication. NIM, on the other hand, allows for communication between users and engenders collaborative work.

3. The subject matter is static and may not always be relevant. While considerable time and expense goes into the production of traditional software, the content is cannot be changed easily and is subject to rapid obsolescence. This is increasingly problematic in a world of rapid change.

4. Adapting the product to render contextual relevance is, at best, difficult. Context is an essential part of learning and, unless the application is dynamic and flexible, it will be limited in scope.

The 1990's, however, have brought about an entirely new generation of technologies that have transformed computers from machines that perform computations faster to essential tools for global communication. The Internet and the World Wide Web together with the new networked, multimedia-based technologies are reorganizing our world. Working with computers has changed from being a standalone, segregated experience to becoming a rich, ubiquitous, community-based experience.

The Concept

We set out to design an application that would have several characteristics that we had determined were important in addressing the shortfalls of CBI applications and, at the same time, maximize the functions of a NIM environment. The challenge was to create an application that would be contextually relevant, dynamic, maximize communications between peers on a nation-wide or global basis while, at the same time, effect substantive learning and be fun to use. Further, the use of the World Wide Web (WWW) and the Internet as an enabling medium was natural due to its low cost, ease of availability for most users and platform independence. The opportunity of engendering new social dynamics through the design of such an application did not escape us either.

After much deliberation, we decided to create Sympatico's *CyberRecess™* - an Internet-based application in which the contexts we provide would form the basis for the creation of dynamic, user-driven content. We were determined that we would create an application with a key difference! *The content is entirely generated by users for consumption by users.* Students effectively become publishers and, through communication with "contextual editors", they can shape the design and development of future contexts so that relevance of the application is assured from a user point of view.

CyberRecess™ is our first application in which a team of "contextual editors" merely set the context. The application has six basic sections that involve science, mathematics, English, art, humor and the "*Wired Goose Chase*"- a section that allows for the development of online research and navigational skills. Forums that allow for the creative expression of ideas will be added in the future. Any student with Internet access can participate in *CyberRecess™*. Submissions are screened and qualified by a team of editors and selected entries are posted. Because content is created by students, it is generally relevant to the user group. The experience is truly empowering as every child is presented with the possibility of authoring, publishing and sharing their work and experiences with other children elsewhere.

While this application is only a small first step in understanding learner-centred multimedia applications, it raises several future possibilities: Will a new social and cultural dynamic be created for students who have traditionally been isolated within the walls of the classroom and who can now communicate with other members of a larger learning community? Can students from other institutions and levels be used to manage the process and can this provide valuable "real-world" work experience for students? Will this foster mentoring relationships between students and experts? The possibilities are endless.

Design and Developmental Issues

There were several critical issues that had to be addressed as we progressed in the design and development of the application.

1. *Learning Goals* - were of primary importance in the design of the application. We have tried to develop an environment that encourages participation and discovery, and yet is fun and whimsical at times. There is a high level of interactivity inherent in *CyberRecess™* and the user has the ability to navigate anywhere they wish. This empowerment of the user is designed to foster attitudes of responsibility and social awareness while surfing online. User generation of content is key to maintaining a constructivist approach to application design. The idea that learning can and should be fun and motivating is paramount.

   A planned addition to development will look at the integration of curriculum-based concepts with the contexts that we set.

2. *Contextual Cascading* - a major issue we faced was the discrepancy in the cognitive domain and the comprehension abilities between eight year olds and twelve year olds. Social attitudes and the attempt to address these issues proved to be major challenges. We tackled these concerns by developing a system of "contextual cascading" in which each module progressively builds up to address higher levels of cognition. For example, the language section may start with a few items that play on words and which might be appropriate for an eight year old and, as the user drills down, the section gets more complex and may provide Internet links to bodies of literature that are more appropriate in addressing the attention span and learning requirements of a twelve year old. Users are always in control and they may choose not to proceed any further if the context is too complex for them. In this way, the abilities and skills of the user are emphasized rather than some arbitrary age-based standard.

3. *Community and Identity* - The most powerful component of the Internet is the ability to chat, participate in forums and generally communicate with others. The sense of community that this engenders is compelling.

In order to develop this sense of identity and community, we developed characters for each section. Within each character we have imbedded one or more of the multiple intelligences. This allows for a unique idiomatic expression that results from the interplay of character, form, intelligence and communication. Users can communicate with one another and with us through e-mail and we will eventually create forums to facilitate discussions between users.

4. *Navigation* - It is essential that navigation be intuitive. *CyberRecess™* has several sections that have to be easily adaptable for user contributions. Each change results in significant effort to reconfigure the navigational programming. During the design phase, several navigational formats were tested including the use of words only, the use of icons and a combination of the two. In addition, the ease of navigation was a primary consideration.

   When dealing with the issues surrounding navigation there is a fundamental tradeoff between "open navigation" - the ability to readily jump to any section of the application regardless of where one might be and "directed navigation" - having to always go back to the home page and then wend one's way to the next desired location. The former clutters the valuable real-estate of the screen with navigational icons while facilitating rapid movement to the desired location. The latter tests the threshold of user patience and can make navigation an onerous process. After much research and feedback from users, we adopted a hybrid-segmented approach that falls mid-way between the two paths described above. Users can always go to the home page, and to the lead page of a respective section that they are visiting, however every page will not necessarily provide access to any other page. This compromise position seems the most acceptable to users.

5. *Internal Development Processes* - An interesting aspect that arose from our developmental processes is the concept that we should be operating in the medium in which we design. After all we were adamant that we had to walk the talk to have any credibility. The necessity of being a high performance team within a "Learning Organization" was important to all the team members. With this in mind, we created a team that operated as a virtual team from their home offices and we created a collaborative development team with shared responsibilities.

   There are inherent problems with such a development approach. Generally, members struggle at first while attempting to establish the commitment and trust necessary for effective collaborative work. One must be ever watchful of the "design-by-committee" approach that can result in counter-productive behaviour. In order to address these issues, team members were given clearly defined responsibilities while at the same time they participated in "brainstorming" sessions that elicited the best from their experience. They continually surprised us through creating unimagined synergies and expanding and extending the application concept. The essence of this type of system is in striking the right balance between collaborative, "group-think" activities and production-based activities.

6. *Management of user-authored content* - is a significant concern. Typically, in multimedia development, a tremendous effort is exerted in the production of content and there is little effort expended in the on-going management of the content. With a user-driven authoring process such as ours, the tables are turned. Development is less "content-intensive" than traditional multimedia, but content management becomes a very significant issue.

   We sought the use of technology to obviate some of these processes and make the process more fluid. When we first started, submissions were primarily designed to be via E-mail and a programmer was required to code the submissions into hypertext markup language (html) and post them to a Web server. We tackled the issue on two fronts. First, we incorporated a Web-based authoring tool so that users could send their contributions directly to us coded in html. Second, we designed a series of templates and underlying databases to streamline the management of user submissions.

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Implications

The implications of a user-authored, dynamic, contextual application such as *CyberRecess™* are significant:.

1. Preliminary information from surveys indicates that students will be motivated and learn faster as the inherent nature of the product demands interactivity. Passive learning is replaced with active discovery.

2. Interactivity and communication foster collaboration and a constructivist approach to creating knowledge. The online nature of the technology allows for a flexible, open-ended interactive experience and as content is user-created it is both current and relevant.

3. Teachers will have to adapt their teaching styles to suit the dynamics and capabilities of the new technologies.

4. Internet usage is being elevated from searching through a vast array of information to using the communication capabilities it provides to engender true inquiry, communication and higher order thinking skills.

Ultimately, we believe that these technologies will have a profound impact on learning cultures. Ideas and the ability to put them to productive use are the new currency of the Knowledge Age and we view *CyberRecess™* as being a small step on the journey in the creation of a culture of lifelong learners.

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MediaLinx Interactive, LP., is funded by several telephone companies in Canada and is in the forefront of developing, packaging and distributing interactive multimedia products and services. Its key service, the *Sympatico™* Internet Service, is Canada's largest nationally-branded Internet service and has received acclamation from around the world.

A Quantitative Approach to Navigation Paths and Behaviour of Inexperienced Users of Hypermedia Documents

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Abstract: This paper focuses on the problem of navigation in hypermedia documents. It describes a study which aim to answer the following questions: what do readers do when they are asked to find factual information from a hypermedia document with the goal of answering specific questions? What readers do when they are asked to study a topic, based on the reading of a hypermedia document? Is the navigation behaviour similar in these differents circumstances?

Two groups of students participated in the study. Group "A" was asked to answer to specific questions based on the content of a hypermedia document. Group "B" was asked to use the same hypermedia document but without having any factual task.

A program was written to generate a data file log that makes a trail of each of the individual navigation paths. An automatic treatment of the navigation paths was implemented to analyse the navigation behaviour.

Introduction

In 1987, Conklin in his well-known article "Hypertext: An Introduction and a Survey", said that "There are two classes of problems with hypertext: problems with the current implementations and problems that seem to be endemic to hypertext" [Conklin 1987, p.38]. Conklin considers that an "endemic" problem of hypertext is the "navigation problem" when he says that there is "(...) the problem of having to know (1) where you are in the network and (2) how to get to some other place that you know (or think) exists in the network." Since 1987, many of the "current implications" reported by Conklin have been resolved as the technology and the hypertext/hypermedia systems evolved but many aspects of the "navigation problem" remain. The "navigation problem" and the "disorientation problem" are reported by many authors [Campagnoni & Ehrlich 1989; Edwards & Hardman 1989; Kibby e Mayes 1989; Bernstein 1990; Boyle & Snell 1990; McAleese 1989, Jonassen 1990; Jonassen & Grabinger 1990; Nielsen 1990; Castelli, Colazzo, Mich & Moliaru 1991; Gay & Mazur 1991; Tricot 1993].

With our research study we have endeavoured to contribute to this major topic of discussion - "the navigation problem" - particularly in what educational uses of hypertext/hypermedia systems concern.

Our study was based on the idea that the answers to the navigation problems on hypermedia documents and the problem of "being lost in hyperspace" will only be known when we can understand and characterize the navigation patterns and behaviours of the users of hypermedia systems. To meet this objective it is important to use automatic register tools to keep track of the navigation paths' users adopts in different circumstances. This specific research tried to describe and interpret the navigation behaviour of users of hypermedia documents in different task context. To develop and analyse different criteria and "indices" to interpret the navigation behaviours was also a research aim.

Objectives

With this project we tried to characterize the navigation paths that inexperienced users of a hypermedia system adopt when they are assigned different tasks. We tried to determine if there are any differences -- and what kind of differences -- between a group of subjects who was asked to answer specific, factual questions based on the content of a hypermedia document and another group who was only asked to get information on the same topic and with the same hypermedia document but without any factual task.

Participants

The subjects who participated in the study were undergraduate students of University of Minho. They were studying Education Technology as part of their *curriculum* and a hypermedia document was used to give them an overview about hypertext and hypermedia technologies and their applications to education. The subjects participated in the study as part of their coursework. They were 25 female students and only 1 male student. This happened because that specific class includes only 3 male students (and 2 of them were absent). The students' average age was 24,5 years. All of the students had similar experience in the use of computers (e.g., word processing and drawing software) but none had previously used any hypertext/hypermedia document. They were acquainted with graphical interfaces (Windows or Macintosh) and input devices such as a "mouse".

The hypermedia document

For the present study a hypermedia document concerning the educational uses of hypermedia systems, entitled "Hypermedia: Myth or Reality?", was developed. The hypermedia document was created with the system "Toolbook" from Asymetrix Corporation. "OpenScript", the programming language of Toolbook[1] was used to create a program ("script") to register all the navigation paths of the users in a log file.

Procedures

One week prior to working on the hypermedia document "Hypermedia: Myth or Reality?", the students were introduced to the navigation process by attending a demonstration. For the demonstration a Toolbook document (a "book") with only six "pages" (information nodes) was used.

After the demonstration session the students were randomly assigned to group "A" or group "B". Students from group "A" were asked to navigate on the hypermedia document in order to answer factual, specific questions and to write the answers on paper. The students of group "B" were asked to navigate on the hypermedia document to get information in order to have a class discussion in the next class hour. Both groups of student were asked to work at their own pace, without time constrains.

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[1] Toolbook uses the "book" as an interface metaphor so that each node of information corresponding to a screen is called a "page".

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An automatic program kept an exact record of all of each student's navigation options.

Instruments and Measures

A key component of this study is the possibilities offered by the information of the logging data file created with "Openscript". The program to generate the data file was written in such a way that every "event" taking place when a student is in use of the hypermedia document was recorded. The data that was made available by the use of this "data log" program which we called "register tool" included:

- the name of each "page" (information node) visited,

- the time of entry in each page

- the objects clicked in each page ("hot-words", "links" and "pop-up windows" that were activate).

Fig. 1 shows the aspect of a piece of an individual navigation path, as recorded by "register tool".

```
Registo automático de percursos de navegação

CAPA / 19:56:40 / Autoria / Avançar
ÍNDICE / 19:56:52 / Sobre o documento / Sobre hipermedia / O que é hipermedia
O QUE É HIPERMEDIA / 19:57:08 / Avançar
ELEMENTOS DO HIPERMEDIA / 19:57:13 / Animação
ANIMAÇÃO / 19:57:23 / Regressar
ELEMENTOS DO HIPERMEDIA / 19:57:23 / Regressar
VÍDEO / 19:57:31 / H-laser / H-Cdi / Índice
ÍNDICE / 19:57:50 / Sobre hipermedia / O que é hipermedia
O QUE É HIPERMEDIA / 19:57:59 / Avançar
ELEMENTOS DO HIPERMEDIA / 19:58:13 / som
SOM / 19:58:23 / H-multi / Placa de som / moreinfo / Cd-rom / H-rom / moreinfor2 / moreinfo3
/ Recuar
GRAFISMOS / 19:59:08 / Regressar
(...)
```

Figure 1 - Part of a navigation path as traced by the register tool

It is important to note that each individual "data log file" consists of a large amount of information that would be impossible to analyse manually. A special program was written, using Pascal, to analyse the data file recorded by the "register tool". This Pascal program was named by us "Analyser" and it calculates the following values:

Amount of time using the hypermedia document------------------------ TT (Total Time)

Average Time the user spends in each "page" -------------------------- AT (Average Time)

Total Number of Visits to "pages" ------------------------------------- TNV (Total Number of Visits)

Number of Different "Pages" Visited------------------------------------ NDPV (Different Pages Visited)

Ratio $\frac{\text{Total Number of Visits}}{\text{Number of Document "Pages"}}$ ------------------------------------- TNV/NDP

Ratio $\frac{\text{Total Number of Visits}}{\text{Number of Different "Pages" Visited}}$ ------------------------------------- TNV/NDPV

Ratio $\frac{\text{Number of Different "Pages" Visited}}{\text{Number of Document "Pages"}}$ ------------------------ NDPV/NDP

Number of Supplementary Nodes Visited-------------------------------- NSNV

Total Amount of Navigation -- TAN=NSNV+TNV

The NSNV (Number of Supplementary Nodes Visited) represents the number of "hot-words", "hot-objects" or "pop-up windows" that were visited. This kind of "node" contains additional information, not very important for understanding the main concepts. The most important concepts were represented in the "nodes" which correspond to a "page". When we refer to "nodes" we are referring to one "page". When we refer to "supplementary" nodes we are referring to "hot-objects" embedded on a page.

The TAN (Total Amount of Navigation) was calculated as the sum of the NSNV and TNV and represents the total number of times the user interacts' with the document.

Tab. I describes the different indices used.

Index	Description	Notes
TT	Amount of time using the hyperdocument	------------------
AT	Average time the users spend in each "page"	------------------
TNV	Total number of visits to "pages"	It helps to understand how "deep" the navigation route was
NDPV	Number of different "pages" visited	It helps to understand how "deep" the navigation route was
TNV/NDPV	Ratio $\frac{\text{Total Number of Visits}}{\text{N. of Document Pages}}$	It helps to understand how "repetitive" the navigation route was
TNV/NDPV	Ratio $\frac{\text{Total Number of Visits}}{\text{N. of Differents Pages Visited}}$	It helps to understand how "repetitive" was the navigation route
NDPV/NDP	Ratio $\frac{\text{N. of Differents Pages Visited}}{\text{N. of Document Pages}}$	It helps to understand how "deep" the navigation route was
NSNV	Number of Supplementary Nodes Visited	It helps to understand how "deep" the navigation route was
TAN	Total Amount of Navigation	It helps to understand how "deep" the navigation route was

Table I - Description of the different indices used

Data Analysis - Results

The program "Analyser" calculates all the indices described in table I based on the data log file of each subject created by the "register tool". After that, we calculated the average and standard deviation for each group of subjects and each one of the indices. Nonparametrics statistics with the Mann-Whitney ("U" test) were also calculated in order to analyse the significance of the differences between the two groups.

Tab. II presents the average and standard deviation for each index and each group of students. It also presents the results the "U" test of Mann-Whitney.

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	Group "A"		Group "B"		
	Average	Std.Dev.	Average	Std.Dev	Mann-Whitney Test
TT (minutes)	43,0	12,3	39,2	(15,7)	**n.s.**
AT (seconds)	23,0	7,6	15,7	(11,3)	**$p<0,05$**
TNV	115,8	44,8	175,0	(75,9)	**$p<0,05$**
NDPV	27,1	3,8	29,8	(3,2)	**n.s.**
TNV/NDP	3,6	1,4	5,5	(2,4)	**$p<0,05$**
TNVN/NDNV	4,2	1,4	5,8	(2,3)	**n.s.**
NDNV/NDP	0,8	0,1	0,9	(0,1)	**n.s**
NSNV	25,5	12,8	34,5	(15,4)	**n.s.**
TAN	129,8	47,1	191,8	(65,6)	**$p<0,01$**

Table II - Average and Standard Deviation for each group and Mann-Whitney test of statistical significance.

From the data recorded on tab. II, it can be observed that, for most of the indices used, the standard deviation related to group B is higher than that of group A. This is not true for the NDPV (number of different pages visited) which we think can be caused by the small size of the hypermedia document (only 32 pages) and by the fact that, as all the subjects could navigate for the time they wanted, they had enough time to see all the existing pages. In this case it could be important to analyse the navigation paths in differents units of time, trying to assess if the initial behaviour of the user was different in the two groups.

We think that the tendency for smaller standard deviation found in group A indicates that the existence of a specific, factual task of information retrieval can reduce the individual differences between subjects in what concerns their navigation behaviour.

The average value of the TT (Total Time) of using the hypermedia document is higher in group A than in group B, but without statistical significance (n.s. - difference not significant).

The AT (Average Time) of node consulting is different for the two groups ($p<0,05$) being higher for group A. *This can indicate that individuals from the group to which a specific task was assigned (group A) spend more time reading the content of each node.*

Individuals from group B seem to have tried a path that includes many nodes without spending as much time reading the content. This idea is supported by the fact that group B presents a smaller AT of node consulting but higher values in what concerns the indices TNV (total number of visits); TAN (total amount of navigation) and ratio TNV/NDP. The differences found between the values of indice TM, TAN and TNV/NDP are also statistically significant.

Group B presents higher values than group A in all the indices related to the NDPV (number of different pages visited)but these differences do not have statistical significance.

Discussion and Conclusions

The results from this study suggest that the nature of the proposed task influence the behaviour of users of a hypermedia document. The results show significant differences between the group of students to which a specific task of retrieval information to answer objective questions was assigned (group A) and the students to which a less concrete task of "getting information about hypertext/hypermedia" was assigned (group B). Note that all the students of group A wrote the correct answers.

From this study it was found that:

- Individuals from group "A" seem to read the information contained in the hypertext document more carefully. They stayed more time in each node ("page") of the hypermedia document (group A: 23,825 second *per* node *versus* 15,698 second *per* node - group B ($p<0,01$)) and they answered to all the questions asked successfully.

- Individuals from group "A" also seem to have more similar navigation paths than those of individuals from group "B" (individuals from group B have higher standard deviation for all the indices than individual from group A). This evidence suggests that the task of "getting information to answer factual questions" results in a kind of "homogeneity" of the navigation behaviour (considering the criteria adopted).
- Individuals from group "B" visited more nodes ("pages") of information than individuals from group "A" but they stayed less time on each hypertext node, which suggests they were trying to have a more general view of the content of the hypertext document. They also visited the same node several times but in many times they stayed just a very few seconds on the node (almost the necessary time to make active another link) which suggests they were trying to make sure they had already "taken a look" at the information contained in the hypertext document (some of the individuals reported this intention).

These evidences of the influence of the "task" on the navigation behaviour are consistent with the results of [Fowler & Murrey 1987; citated by Stanton & Stammers 1990] and [Trumbull, Gay & Mazur 1990], whose studies despite using differents approachs, points in the same direction.

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Integrated Development and Production Tools for Building Hypermedia Courseware and Interactive Scenarios

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Abstract

Developing hypermedia instructional environments is a labour intensive enterprise, and there are certain inefficiencies inherent in current design, development and production methodologies and in the tools which drive these methodologies. Arguably, certain improvements in overall development and production time can be achieved with new tools. In particular, tools which can support iterative design and testing and the various phases of development and production, all within one integrated environment, might provide the basis for compressing the cycle of design, development and production. In this paper we argue that such tools can be developed by marrying database technology with the capabilities of media presentation software. Two examples of this approach are discussed. The first is a course development environment. The second is a tool that supports the design, development, production and maintenance of interactive scenarios.

Introduction

Developing computer-based learning, particularly hypermedia environments, is a time-consuming enterprise. In fact, instructional development is one of the few areas in which the intrusion of computer technology has actually increased rather than decreased product development times. The reasons are largely related to the nature of current methodologies and tools.

There are really two general methodologies that can be followed. Each has its own pitfalls and advantages but both are relatively inefficient. In this paper, we first describe, very briefly, the two methodologies, and pinpoint the reasons for their inefficiency. We then suggest that part of the problem is that existing tools support, and limit us to, these particular methodologies. We argue that a different, more efficient, model for development and production can be implemented with tools designed with a somewhat different philosophy in mind. What must be built is a single environment which a) supports iterative design and formative evaluation, b) integrates development and production phases, and c) offers the efficiencies of templates but provides greater flexibility than existing authoring environments and shells. The technology required is available presently based on the creative marriage of database capabilities with media presentation software. Finally, we describe two authoring tools under development which we have designed with this approach.

Methodologies for Instructional Development of Hypermedia

Currently, instructional multimedia development follows one of two models. In the first, a traditional, procedural instructional systems design (ISD) methodology drives the process. The second is based on rapid prototyping.

ISD Driven Approaches

In the first approach, there are discrete steps which follow in a more or less linear sequence: identify content, develop objectives, select instructional or presentation strategies, select media, develop standards and style guides, develop content (script, storyboards), produce media components. Following these various design and development activities, there is the production phase in which all the content is integrated within some functional application.

There are two variations within this approach, which depend on choice of technology. One option is to utilize an authoring shell, a kind of preprogrammed template or model into which the content is poured. The shell may be custom built: a one-off design programmed for a particular application. Or, it may be a commercial shell. In either case, there are problems with the overall methodology.

Using a commercial shell is not acceptable to most developers. Shells typically have their roots in earlier CBT models. They tend to have limited support for multimedia, and their designs are too constrained, too inflexible. Moreover, existing products do not succeed in furnishing a seamless environment for manipulating and integrating media components. An alternative to using a pre-designed commercial shell is to produce a custom-designed shell using either a media presentation tool, a hypertext authoring tool that supports multimedia, or a CBT authoring environment that supports multimedia. The problems here are as follows:

- the process is time-consuming and justifiable only in the context of larger projects or, at least, larger budgets,
- such shells are generally one-offs which are not re-usable or readily adapted to other projects,
- the process of designing the shell must take place at least concurrently with the overall content design and development process and this concurrency, which involves teams of individuals with separate kinds of skill and knowledge, is difficult to manage and coordinate successfully and cost-effectively,
- development of specifications for the shell usually proceeds through a prototype development process which is costly and inefficient: the tools employed for rapid prototyping and representation of designs and capabilities are rarely the same tools which will be used to construct the actual shell
- even when a custom shell is engineered, it will not typically provide a seamless environment for manipulating and integrating the different media components and therefore considerable technical expertise will be required to assemble the final product,
- development occurs in a separate environment which does not allow for testing the usefulness of linkages among the elements of content, or for otherwise effectively managing the design of a document with many cross-links.

These factors contribute, collectively, to the substantial overall development times and costs associated with hypermedia projects.

Rapid Prototyping

An alternative methodology utilizes rapid prototyping to design the product through an iterative process. This approach has the advantage that it builds in formative evaluation from the outset, as an integral part of the development process. Thus, the likelihood of costly revisions to the design being required at the production stage are minimized, as compared with a traditional ISD or traditional software development approaches.

However, all the problems mentioned above with respect to the enterprise of building a custom shell apply once more:

- the inefficiencies attributable to one-off results and the use of different tools for prototyping and for final production,
- a design and development process which is difficult to manage,
- and the separation of content design and content development environments.

A Technical Solution

What is required, if product development and production is to be made more efficient, are development tools which offer the following capabilities:

1. They should accommodate different templates for different projects with their own specific requirements regarding structure, navigation, user options, interface design.
2. They should furnish a production environment which allows a person without technical training to manipulate, organize, structure and integrate different media and generate the final product.
3. They should also represent a development environment in which content can be composed and formatively tested in a hypermedia format.
4. The content (the media assets) should be maintained in a form that makes it easy to access and review content either for use in a specific project or for re-use across new projects.

Our argument is that product development times can be improved if these criteria are met. The main thrust of the approach is thus:

- to allow development and production to take place in a continuous process within one environment,
- to place tools in the hands of the content developers which will allow them to produce the final product with minimal effort, and,
- to provide tools which will allow for the testing of organization and functionality from the outset of the content development phase (something which is problematic when content development is carried out with word-processing or desktop publishing software).

We are currently building two tools which meet these requirements. The first is an environment for building hypermedia documents. The second is a tool for building interactive, branching scenarios. These tools are described below.

The Hypermedia Builder

Designing and developing interactive multimedia courseware requires several steps typical of most development of instructional material. The major steps are: identifying learning objectives, developing content, structuring and linking content, producing the necessary media assets, and developing and producing the "shell" through which the content will be presented to the learner.

Shell development requires the involvement of a multimedia developer, who programs the software and integrates the media assets. This creates a dependency on the developer since very specialized activities requiring technical knowledge and skill are involved. It is expensive and typically not conducted on site. It creates a lag between the design of the shell, the development of the content and actually seeing results, which only then can really be evaluated.

The Concept

The idea behind the Hypermedia Builder is to provide an environment in which the content developer can not only create and structure content and questionnaires, but build and test hypermedia/hypertext links, integrating media components, indexes, glossaries, references and feedback.

An important feature of this tool is that as soon as content begins to take form, the content developer can start to view it from the learner's perspective. Once the content and structure is completed, the content developer can generate, through a straightforward process, the package that will be given to the learner. In the case of more elaborate and bigger projects, this package can also serve as a fully functional prototype on which a more elaborate production could be based.

The Application

The process of creating a new course begins by creating a new database in which all information for that course will be stored. There is no preset procedure. All relevant information can be added in the order most suitable to the author. One can start developing bits of content at a time, or go systematically one module to the next.

For example, one may start by first integrating media assets into the database with the Media module. The media assets can be graphics, sound, animation, digital video, QuickTime VR, as well as other interactive components such as tests, tasks or games. Each are stored with specifications inherent to their identity, such as width, height, duration, sample size, and so forth. Different aspects of the content are then developed within the following modules:

- the Main screen in which courses are created and opened,
- the Modules screen in which modules are added to the course,
- the Sections screen in which text, indexes, glossaries, references and media elements are added to the module,
- the Questionnaires screen in which questionnaires are added to the course,
- the Questions screen in which questions and feedback are added to the questionnaires.

As the content of the course is developed, the content developer can use built-in features to integrate all the information together. Important features are as follows:

- any media can be assigned to any individual section,
- hypermedia links can be assigned to specific bodies of text,
- voice overs and embedded tasks can be assigned to any section of a module,
- personalized indexes and glossaries can be built,
- questionnaires can be built and linked to any module,
- questions can be supported by any media, and linked to any section,
- answers to the questions can incorporate individual feedback,
- references can be inserted anywhere in the text.

As materials are integrated and the structure is elaborated, the results can be viewed directly within a variety of generic and/or custom learner interfaces. This allows the content developer to view the final product immediately, thus verifying the effectiveness of her intentions without delay.

The Hypermedia Builder provides a single integrated environment within which content developers may write content, develop course structure, conduct formative evaluation, and achieve final production. Since the tool is structured around and driven by a database engine, the task of course revision or modification is simplified. The prospect of being able to manage a large repository of media assets in order to produce course modules in a cost-effective manner is greatly enhanced.

The Hypermedia Builder offers a set of interface designs or templates for the learner interface, from which the developer may select. If need arises, these standard designs can be modified to meet specific requirements of any project. Over time, a large selection of interfaces could be developed to satisfy the needs of most learners.

The Scenario Builder Tool

In the contexts both of training and education, there is increasing demand for greater interactivity to be built into materials. In particular, of late, there is a great deal of interest in the use of interactive scenarios [Cognition and Technology Group at Vanderbilt, 1992; Shank, 1994]. Extended scenarios are seen as a vehicle for developing problem-solving skills, while scenarios in general are regarded as effective tools for transferring skills and knowledge to operational environments, for developing soft skills [Kass et al, 1994], for teaching processes and procedures, for teaching via story-telling [Feifer & Hinrichs, 1992] and for increasing the learner's interest and motivation.

Unfortunately, scenarios, particularly those with complex branching structures and dependencies, are difficult to design and, owing to the logic, time-consuming to produce. Again, we have applied the rationale outlined above, this time to produce a prototype, Scenario Builder, which facilitates the design, formative evaluation and production of interactive scenarios. The tool also simplifies the maintenance or modification of scenarios, and the re-purposing of existing scenario material or structures for new projects. As with the Hypermedia Builder, the idea has been to combine a custom multimedia-capable database with media presentation software. The result is an environment in which scenarios can be built up in a frame-by-frame iterative design process. The tool keeps track of the emerging structure, which can then be tested and modified on the fly. The number of options and/or number of decision points can be modified easily and the entire structure of branching paths is automatically adjusted accordingly.

The environment can be used for development and formative testing and also for final production. Each frame can contain text, graphics, sound, animation or digital video clips. These media assets are contained in a database, readily accessed, reviewed and placed in the scenario by the content developer without the need for technical expertise.

Different media components are accessed and structured directly within the environment of Scenario Builder. Currently, it is being developed to include the capability to take snapshots right in a work environment, using a video recorder, so that operational environments and scenarios can be easily and accurately modeled and depicted. The environment will allow for the direct capture and integration of voice or video, either for development purposes or for final production. Thus, Scenario-Builder is also a powerful tool for capturing and modeling specific processes or procedures, whether they are heavily branched or essentially linear. Finally, any material constructed with the Scenario Builder will be treated as a media asset within the Hypermedia Builder environment.

Scenario Builder thus represents an integrated environment to design, prototype, evaluate, develop, produce and maintain interactive multimedia scenarios. The integration of these tasks within a single environment, which can be used by an instructional developer who may lack programming skills, should provide significant efficiencies.

Conclusion

We have described two tools which are intended to provide an environment in which content developers can carry out design, development and final production work in a continuous process. By integrating these tasks, and by automating certain production tasks (such as building links and navigation tools), certain efficiencies should result. First, there is less requirement for technical programming skills. Secondly, materials do not have to be translated from the development environments (word processing packages, separate databases and so forth) and implemented in a separate production environment.

Of course, many of these objectives have been achieved with other products, including a host of commercial applications. The more unique contribution of tools such as Hypermedia Builder and Scenario Builder lies in their integration of development and production environments within a database driven system.

An added dimension to Scenario Builder, not discussed above, is that it could serve as an environment for learners to build and explore their own scenarios, or to model processes or procedures. These activities could be carried out individually or collaboratively. More generally, Scenario Builder could also serve as a useful tool to support scenario-based design activities for system development [Carroll, 1995].

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Implementing Educational Technology: Professional Cultures and Collaborative Efforts

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Abstract: Increasingly, educators and professionals whose expertise lies in the area of computer technology are working collaboratively, with the goal of providing enriched technology- based learning experiences for students. Yet, little consideration has been given to how the culture of such technical communities interacts with that of the schools, potentially influencing the effectiveness of such school change efforts. This paper explores this issue, drawing on interviews, field notes, and archival data collected over four years as part of a case study of the introduction of the Internet into a large urban school district. The findings shed light on the need to make explicit cultural values and norms and to work to develop effective ways of bridging cultural differences between educators and computer professionals in order to facilitate productive collaborative efforts to implement technology- supported learning.

> Educator: You know, I think what happens is the education people look at it one way, the tech people look at it the other way. There's tension there which I think originally was a very creative, productive tension. But to me it's deteriorated to the point where I think it's debilitating to the project rather than adding a creative force...

Increasingly, school personnel and technology experts are working in collaboration, seeking to improve technology-based learning experiences for students [Lyman 1996]. Collaboration appears both sensible and necessary. Yet, as the educator who speaks above laments, it is one thing to aspire to a collaboration and another to realize its potential.

This paper describes issues that have arisen in Common Knowledge: Pittsburgh (CK:P), a collaborative effort designed to bring Internet access to the Pittsburgh Public Schools. As a collaboration, CK:P is designed to draw on the unique insights and expertise of public school, technical, and university personnel. A project education staff, comprised of former classroom teachers with non-technical backgrounds, is responsible for training teachers and supporting curriculum development. They also typically communicate teachers' needs to the project technical staff. Technical personnel, based at the Pittsburgh Supercomputing Center, include individuals with diverse skills relevant to implementing school-based networks. Their previous experience with educators is limited.

As others have noted [Crowson & Boyd 1993; Knapp 1995], there is a need to consider forces and conditions that impinge on collaborative efforts; however, there has been little analysis of organizational issues that may affect such ventures. Here, we describe key features of technical and educational workplace cultures and explore how cultural factors have affected CK:P's efforts to implement networking technology. Our purpose is to illustrate how contrasts in the norms, values, and routines associated with professional cultures can affect collaborative efforts. It is important to note that despite the tension and conflict described CK:P has accomplished much in four years - getting 64 schools on line, cultivating many Internet-based classroom projects, encouraging demand for technology from teachers, and developing a distributed system architecture. Yet even more might have been accomplished if the collaboration had worked more smoothly.

Methods

We draw on qualitative data collected over four years time, including email, field notes taken at staff meetings, and interviews with the technical staff, educational staff, and public school teachers responsible for using networking technology. Field notes and interviews were audiotaped and then transcribed. Each of the data sources was coded and analyzed using established methods such as those described in [Miles and Huberman 1994] and [Corbin and Strauss 1990].

The Professional Cultures In Question: Key Characteristics

Below, we identify and compare cultural aspects of the educational and technical worlds as they were evidenced in CK:P. In doing so, we do not assert that all members of the educational and technical staffs perfectly reflect these descriptions. Rather, these are factors that individuals embedded in their cultural settings are both aware of and orient towards, though they might individually reject or resist them.

Contrasting Values: Innovation vs. Tried and True

CK:P's technical staff value experimentation and development; they are interested in playing with and deploying new, cutting edge systems and software and are motivated by the challenge of improving existing systems. Thus experimentation may take place purely for its own sake; that is, even when practical implications are not immediately apparent. The emphasis on experimentation and development means also that CK:P's technical staff operate in a culture where change is the norm. Individuals routinely adjust to new situations, update skills and acquire new ones; indeed they must do so to survive professionally.

In contrast, CK:P educators are part of a pragmatic professional culture where members prize tried and reliable practices with predictable outcomes. Teachers - ever short on time - seek things which work. They are most interested in things with immediate application that address practical problems. Further, though many CK:P educators are open to exploring new technology, many are not comfortable frequently changing established classroom routines in response to technical updates since they feel this will likely be disruptive.

Contrasting Rhythms and Routines: Flexibility vs. Structure

Both PPS teachers and PSC technical personnel emphasize that rhythms and routines in their institutions differ from other workplaces, but the images they convey are strikingly different. CK:P's technical staff describe a relatively unstructured work setting tolerant of divergent work patterns and individual preferences. While priorities and deadlines are set, individuals determine work hours and how they will approach particular tasks. Often they work at home, at night and on weekends, rather than during conventional work hours.

Teachers' lives, in contrast, are dictated by a set daily schedule and structured work setting. They have little choice about who they will see, or when they will complete certain tasks. Further, unlike technical colleagues, teachers have little choice about where they will work. Thus, teachers are ever aware of timing, as they must complete tasks in a particular room in a pre-specified amount of time.

Contrasting Norms: Autonomy vs. Social Control

CK:P's technical staff included individuals who could be considered "hackers" or at least as having been quite influenced by hacker culture--which tends to be individualistic and idiosyncratic and to embody an ethic of toleration for what others might consider strange as well as disdain for those who impose rules and regulations [Sproull, Kiesler, & Zubrow 1984; Turkle 1984].

In contrast to this emphasis on autonomy and self-direction in the technical world, scholars have pointed out the inherent conservatism of the teaching profession [Lortie 1975; Metz 1990; Sarason 1972]. Teachers, who work incessantly with large groups of students tend to control what, when, and how material is presented; to direct student movement and interactions; and to dominate classroom discourse [Goodlad 1984]. Educators involved with CK:P differ from this in the sense that many favor pedagogical and curricular reforms that could prove disruptive to existing classroom relationships and authority structures. Yet, as adults in a world of children, and as the person ultimately responsible for students' safety, deportment, and learning they often felt the need to exert their authority and to emphasize the importance of order and social control.

Contrasting Orientations: Mastering an Instrument vs. Using a Tool

For CK:P's technical staff, computers are instruments which demand care, warrant tuning, and require continued practice to master. Willingness to "play" with technology is seen as critical as technical staff believe that it is only by making mistakes that one builds technical expertise. Consistent with this, they hope teachers will not only broaden their knowledge of Internet resources but also their knowledge of hardware and software. As one put it, "I do not believe in making systems easy enough for an idiot to use....if you make it that easy, people will learn nothing and you will be stuck supporting them for the rest of their lives."

In contrast, for CK:P educators computers are a means to an end - tools to enhance the curriculum or student interest in the curriculum. The education staff thus seeks to familiarize CK:P teachers with network resources, and encourages teachers to spend time on line becoming comfortable and familiar with the Internet. Beyond this, they are concerned that user administrators gain enough technical knowledge to maintain school-based machinery. However, rather than advocating the development of high levels of technical expertise, they have argued that user administrator's tasks should be easy, quick, and guided by documentation.

Interfacing Between Two Worlds: Implications for Implementation

The cultural differences just discussed are reflected in unvoiced assumptions, competing agendas and conflicting technical expectations. Such assumptions, agendas and expectations have slowed project implementation, wasted employee effort, and affected employee morale. To illustrate this, here we briefly describe instances of culturally based conflicts.

Cultures Create Assumptions: The Case of Printing

The CK:P technical staff have had to prioritize the tasks associated with implementing school-based access to the Internet. Typically, they worked first to deploy machinery relevant to Internet access. Printing capabilities were deemed a low priority and were significantly delayed. As a result, teachers felt that their needs were not met and did not use the Internet as much as they would have had printing been available. In hindsight, it is apparent that the educational staff assumed that the technical staff understood the importance of printing, while the technical staff assumed that printing was relatively unimportant.

The technical staff's failure to anticipate printing's importance to teachers can be understood largely in terms of two cultural factors: their immersion in a world characterized by flexible workplace routines and their preference for experimentation and cutting-edge technology. With the technical staff generally able to log on when and where they please and the expectation that interactions between coworkers can occur at off hours, paper-based communication is viewed as redundant and not necessary to insure that all have the same information. Assumptions about printing's lack of importance were likely exacerbated by the technical staff's preference for experimentation. As one put it, "[People in the technical world might say] 'Oh, it's just printing. It doesn't involve TCP/IP and networking and...' blah, blah, blah, blah. It's not as sexy, and so I think we gave it a lower priority because of that." In contrast, for educators in a structured world paper remains essential for communicating efficiently and regularly with student co-workers. Neither teachers nor their students have guaranteed home access and paper frees class time. Teachers do not have to wait for students to copy assignments from the board or organize time so that all have the opportunity to look at a computer screen.

Cultures Create Agendas: The Case of "Oberon"

Contrasting technical and educational cultural values have also been reflected in competing project agendas. Consistent with a preference for experimentation and comfort with change, for example, the technical staff has put in place a networking system that will allow continued development. Particularly during the first two years of the project, they also championed frequent system improvements that would enhance efficient administration of the network. In contrast, reflecting a pragmatic outlook, educators tend to ask first and foremost for a reliable and predictable system. While they do favor system improvements that enhance their ability to carry out curriculum projects, at times they frown on improvements with limited educational relevance.

To illustrate the implications of this dynamic, we describe an incident involving the system server ("Oberon") which provided teachers' access to the Internet during the first two years of the project. During the project's second year, CK:P's system administrator learned about a newly available update for Oberon's operating system. Excited that the update would streamline some system administration tasks, the administrator deployed it during the 1994-1995 PPS holiday break. Returning from vacation, educators discovered to their dismay and in some cases outrage that this technical experimentation had several ramifications for educational practice. Most notably, some teachers lost the ability to create student accounts. In addition, teachers lost access to Internet Relay Chat. Over four weeks, the education and technical staffs received telephone calls and 22 written email messages concerning lost access to curricular resources. The incident precipitated substantial project conflict, leading to hours of discussion but no completely acceptable solution.

Cultures Create Expectations: A Case of Software Development

Contrasting visions of computers and the knowledge that technology users should possess are reflected in expectations for the project's technical products, including software and documentation. Here, we describe discussions about a software package called PC-Remote Build. This package is designed to help PPS teachers who function as user administrators prepare computers for network access and also to "restore" CK:P supported software packages to a machine without destroying or removing local, non-CK:P supported software that teachers have added on their own volition. However, PC Remote Build has the disadvantage of removing program icons that indicate the presence of teacher-installed local software on a machine. Realizing this, and consistent with their orientation towards mastering technology, some technical staff members initially argued that teachers should seek the knowledge needed to overcome this product limitation: "The ed staff wants something no one has to touch....we want something that will do the job. And if that means that you have to have some understanding about how Windows stores files, then it means you have to have some understanding about how Windows stores files." From the perspective of the education staff and project director, however, such arguments are not valid. They do not view PC Remote Build as viable because it requires too much technical expertise - it is not a user-friendly tool.

The technical staff has responded to this criticism by declaring some of the package features "dead," agreeing to redesign the user interface, and reiterating the software's merits. From their perspective, the educational staff's fixation on a restore function that ignores local software blinds them to the benefits of the package: "...somebody with a technical background realized how advantageous this package would be because nothing like it exists, whereas the ed staff completely misses the point of the project." However, the education staff, believing the ability to restore machines without touching local software critical, remain unsatisfied.

Towards Improved Collaboration

With interest in the educational uses of networking technology growing steadily, it is likely that interactions and collaborations between educational and technical professionals will become increasingly common. It appears to us that at least three approaches might be taken to facilitate more effective collaboration. First, collaborations might consider creating roles for personnel with both mediation skills and knowledge of the norms, values and routines of collaborating institutions. Such individuals might serve as translators of sorts, facilitating interactions and ideally anticipating misunderstandings that might arise. Second, collaborators might investigate and make explicit professional cultural values and norms, and then specify before the fact matters related to information sharing, pooled resources, roles, and conflict-resolution procedures. Finally, collaborators might work in the same physical space to help them become more familiar with the work conditions and constraints each face. A modified version of this sort of arrangement has been tried recently with marked success on the CK:P project.

Not all potential pitfalls in technical-educational collaborations can be foreseen, but if schools intend to embark on such they might anticipate the possibilities of such problems and build in processes for recognizing and resolving them.

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TATE: ISDN-based Videoconferencing in Preservice Teacher Preparation

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Abstract: TATE (Technology Assisted Teacher Education) is a preservice teacher preparation project underway at the University of Michigan. The project utilizes synchronous videoconferencing to facilitate classroom observation and the discussion of teaching practice between current and preservice teachers. This paper focuses on educational issues of the project as well as the technical setup, budget, support considerations and outcomes. The full text of this document may be found online at: http://demonsterweb.oit.itd.umich.edu/tate/tatefull.htm

Introduction and Background

In the summer of 1996, Dr. Anne Ruggles Gere of the University of Michigan School of Education embarked on a project to use videoconferencing tools to provide preservice teachers with a more thorough knowledge of practice than has been available in the past. The resulting project, TATE, is the first in a series of distance learning applications in the area of preservice teacher preparation at the School. Lessons learned from the pilot will be used by Dr. Gere and other School faculty in making authentic external observation environments available to their students. This paper briefly summarizes the educational setting, instructional and institutional objectives, technical considerations, budget issues, instructional methodology, and outcomes of the pilot project.

But first a few words on nomenclature: Over the past several years the phrase *distance learning* and its variants have become loaded with implicature for most readers, and it is with some reluctance that we use this terminology in reference to our project. This reticence is largely the result of the dissonance between what is typically conceived of as distance learning (i.e. an instructor lecturing to remote sites via videoconferencing tools) and our implementation. In short, TATE is much more oriented toward close observation of classroom and inter-student dynamics, and collegial discussions between preservice and exemplar active teachers than *talking head* information delivery. However, lacking a more universal term to describe this application of synchronous videoconferencing and observation, and in light of the need for a common vocabulary, we will refer to the set of technologies in this project collectively as distance learning.

Another important piece of background information to understand is that this project is taking place in the context of a partnership between the U-M School of Education and the U-M Office of Instructional Technology. This partnership provides an extremely rich environment in terms of technical support, expertise and resources.

Educational Setting

TATE is a technological extension of a semester long co-mentoring program between U-M undergraduates and grade school students in Southfield, MI. The student pairs work together providing the undergraduates with direct experience with pupils, and the 6th graders with personalized instructional feedback and attention. The undergraduates also have the opportunity to observe Ms. Schiller (one of the first teachers certified by the National Board for Professional Teaching Standards) in action, as well as discuss with her various aspects of practice.

The University students travel to the classroom to make first-hand observations and to have direct contact with their partners. This level of direct observation and interaction is impractical for more than a few sessions however, particularly when the distance between the schools and the impact of 25 additional adults in the grade school is considered.

Neither set of students are technologically advanced in terms of computing skills, but like most students in the 90's, they do have very high standards regarding audio and video quality.

Instructional and Institutional Objectives

The instructional goals of the project were determined by Sean DeMonner and Ron Miller in consultation with Dr. Gere and Ms. Schiller. The institutional goals were defined by key faculty, administrative staff, and technical support personnel on the SOE/ITD Partnership committee.

There are three primary instructional objectives of the project:

- Allow preservice teachers the opportunity to observe Ms. Schiller's class without undue impact
- Provide preservice teachers with the opportunity to discuss practice with an exemplar teacher
- Provide Dr. Gere and her students with a common observational frame of reference upon which to base their discussions of teaching methodologies

The institutional goals of the project include:

- Understand the capabilities of emerging distance learning technologies and gain experience with the types of interactions and communication possible in various instructional contexts
- Develop a better understanding of the costs (capital and ongoing) and staffing requirements associated with distance learning applications
- Build the necessary compliment of equipment, instructional design expertise, and technical support required to provide the School with easy access to external environments via mid-cost distance learning equipment
- Develop an evaluation methodology for determining the efficacy of distance learning implementations

Technical Discussion

Once the instructional context of the project and the goals of the projects were understood, the project team entered a design and testing phase which focused on the analysis of various interaction scenarios and potential technical solutions.

Low end IP-based videoconferencing applications were considered (CUSeeMe/White Pine), but abandoned due to inadequate audio fidelity, poor video frame rates, and the unpredictability of service delivery over an open network (i.e. the Internet). Higher end satellite and T1/T3-based connections were also considered, but reluctantly ruled out due to financial considerations. After some investigation of mid-range videoconferencing tools (PictureTel, etc.), the project team chose ERIS from RSI Systems Inc. due to its mid-range cost, high quality audio, acceptable point-to-point ISDN video performance, and cross-platform capability. A demonstration system was procured from the local ERIS reseller (MiTech, Inc.) and ISDN lines were installed at each end of the connection.

After several frustrating attempts to resolve ISDN configuration problems, the first successful connection was made between Ann Arbor and Southfield. Once the connection was up and reproducable, the specifics of room setup, camera placement and micing could be considered. Although the configuration changes with the type of interaction planned, the typcial setup is shown in Figure 1.

As is indicated on the diagram below, the two rooms are linked via a 128K ISDN connection (2B+D) which covers the forty miles between the sites. The U-M site has two overhead microphones and two video cameras which pick up room audio and video from participants in Ann Arbor and relay it via ERIS to Southfield. There is also a FlexCam and microphone at the Macintosh workstation for private, face-to-face conversations. The ERIS software allows the various video inputs to be dynamically selected, while audio is routed through a mixer located at the workstation. Students typically face the front of the room where the remote image is projected onto a whiteboard surface. Remote audio is piped into a house audio system. The overhead mics and front-placed video cameras allow students to address the projected image as if speaking through a portal to Southfield.

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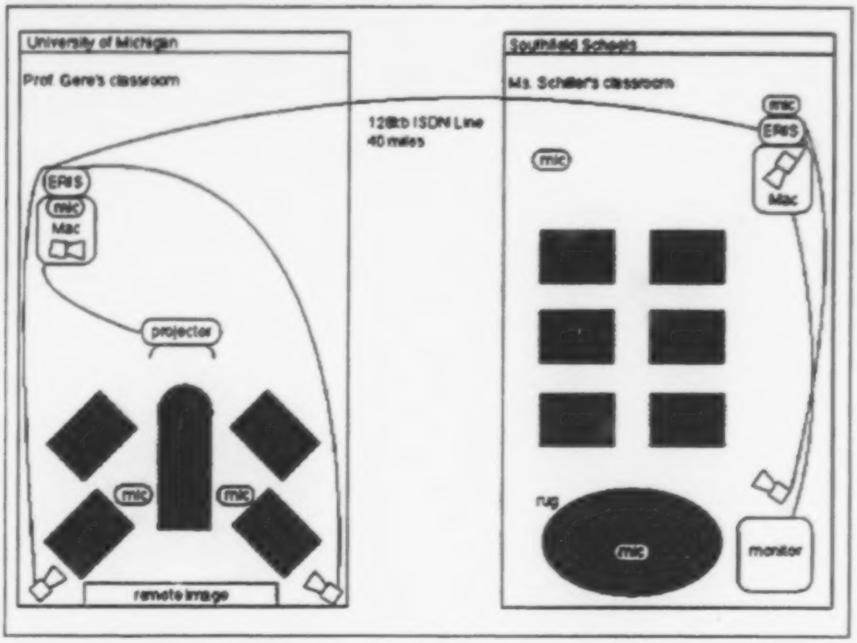

Figure 1: Diagram of TATE setup

The Southfield end of the connection is somewhat different. The ERIS, video cameras and mic equipment are similar, but the remote image is displayed on an overhead television monitor and the outgoing camera views are much more dynamic as a result of the shifting observational focus. The Southfield setup can provide face-to-face private conferencing (at the Macintosh station), small group observation (at the tables), large group observation (when students gather around the rug) and situated interviewing (when Ms. Schiller is standing at her desk at the back of the room discussing practice).

As implied above, the largest hurdle to be overcome in the technical arena was the installation and operation of the ISDN lines. These difficulties ranged from the ridiculous (trying to connect through the wrong jack) to the mystifying (telephone company line misconfigurations and communication gaps). Unfortunately our local phone company seems to have difficulty supporting ISDN, and so we offer to others seeking to use this technology some bits of advice:

- develop a strong personal relationship with a *responsive* person at your telephone company who will follow through on your order
- be sure you order and receive for each ISDN line:
  - an NT1 line terminator
  - a power supply for the NT1
  - any necessary adapters associated with your particular device
  - the correct line configuration (e.g. 2B+D) for your application
- be present when the line is installed and be sure you *see* the technician run a test on the line to confirm its operation
- get and record the following from your installer or representative *before* they leave:
  - your SPIDs (phone numbers)
  - your dialing prefix (if any)
  - your type of switch (e.g. Northern Telecom, AT&T)
- know where the line enters the building and comes into the room
- know what the installation and toll charges will be before installation

Some of these items seem ridiculously obvious, but our own experiences with a small army of technicians, many wasted hours and lots of stress recommend thorough preplanning and close

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monitoring of the ISDN installation and configuration process. If your institution has dedicated telecommunications specialists it would be wise to include them in the planning process from the beginning.

Budget and Staffing

The budget for the project was roughly as follows:

Equipment costs:	
Audio-technica smartmixer	$500
microphones (5)	1400
ISDN installation - Ann Arbor	800
ISDN installation - Southfield	550
ERIS ISDN boxes (2)	8000
Tape stock (50 Hi8)	400
	$11650
Preexisting equipment*	
Hi8 video camera and tripod (4)	$8000
PowerMac 8500AV stations (2)	10000
Projection and audio system	variable; 4000 min.
FlexCam	400
	approx. $23000
Ongoing costs:	
ISDN toll charge - A2 to Southfield	.25/minute
Line charges - Ann Arbor	$30/month; $360 year
Line charges - Southfield	$36/month; $432 year

Table 1: TATE project budget

* These items were already owned by the School and so did not need to be purchased again for the project. It is fairly obvious however, that had these resources not existed, the cost of the project could easily have tripled.

The time investment from instructional design and support staff has been approximately 160 hours, roughly 40 of which were in direct support of live connections (the rest being devoted to designing, testing and troubleshooting). It should be noted however, that this figure includes neither Dr. Gere and Ms. Schiller's involvement, nor George Brackx' support investment. Were those hours to be included, the total would easily top 200 hours.

While the overall amount of cost and human resource investment is certainly significant, and perhaps daunting, it is expected that future implementations will not have to contend with the same ramp-up issues as the pilot. It is also hoped that lower cost technicians (e.g. graduate students) may be trained to deliver the live technical support necessary for successful use of the system.

Instructional Methodology

In all, the synchronous videoconferencing system was used in six discussion and observation sessions during the pilot program, for a total of about ten hours. Several different kinds of interactions and observations in support of preservice teachers acquiring a knowledge of practice were attempted:

Face to face exchange: Students were able to directly and privately communicate with their partners.

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This connection was facilitated more in an attempt to get students comfortable with communicating over the link than to provide significant co-mentoring contact. The sessions tended to be quite short.

Small group observation: This observation scenario allowed University students to observe the outcomes of particular methods applications (e.g. self assessment by 6th graders). It also allowed for observation and discussion of peer interactions (i.e. grade student to grade student). Audio and video from a preselected set of students was delivered and subsequently discussed by Dr. Gere's students.

Large group to large group discussion and observation: During discussion, both groups were able to see, hear and speak with all participants. This type of discussion was difficult for the Southfield students however, because they could not resolve remote individuals in the relatively smaller display monitor. This problem was partially addressed by placing a remote video monitor in the group circle at the front of the room. As an observation tool it allowed University students to see classroom layout and management, and to get a sense of the overall classroom dynamics (noise levels, movement, etc.). The graininess of the ISDN bandwidth video disappointed some however, in that it made it difficult to clearly observe details of the remote activity. Audio, while overall very good, occasionally became loud as the activities in the remote room increased in amplitude.

Individual to group discussion (situated interview): Perhaps the most traditional application of distance learning technologies, this scenario was also the most technically successful (clear audio, good video, etc.). Ms. Schiller took questions from and discussed various aspects of practice with the U-M undergraduates while standing at her desk at the back of the room. However, as a vehicle for allowing observation of inter-student and classroom dynamics it was obviously appropriate. Most of the sessions began with this type of interaction then moved to one of the observation scenarios described above.

It should be understood that these divisions have been made relatively arbitrarily for the purpose of discussion. Despite the fact that the observational agenda was predefined, in actuality the observational flow of the connections was much more fluid than might be conveyed by the previous descriptions. This flexibility allowed for a relaxed approach to the interactions and a much quicker assimilation of the technology by the students than a more formalized approach might have encouraged.

Summary of Outcomes

There is relatively little that may be said in the way of summative evaluation immediately after the first semester of pilot use and data gathering. A more formal summative evaluation is being undertaken now by Dr. Gere and the project team. For the next semester the team will determine, through close analysis of captured videotape session data and student feedback and journals, the longer term efficacy of this particular distance learning technology in the area of preservice teacher preparation.

There is however, much of value that may be conveyed in the way of formative evaluation. Structured observation, student surveys, project team debriefs, and preliminary videotape screenings have strongly suggested the following opportunities for improvement:

- initial student orientation and expectation setting was inadequate (many students seemed to believe that the connections were intended to provide contact time with their partners as opposed to observation and practice discussion).
- initial faculty preparation and technical briefing was inadequate (this was partially due to the fact that our ISDN connection woes continued until the very last moment)
- initial communications protocols were inadequate (speech collisions were frequent and required uncomfortably long periods of time for recovery)
- determining appropriate lighting conditions was difficult and variable
- determining appropriate micing setup and levels (particularly in Southfield) was difficult
- students want better quality video than can be supplied over a 128K ISDN connection
- making students move to preestablished spots to ask questions decreased their tendency to interact and favored the extroverted students
- visibly reconfiguring the software and hardware during connections was extremely distracting
- development of a pre-connection checklist to ensure standardization of lighting, mic settings, software configuration, etc. would greatly reduce variability and increase confidence

There were also several fairly obvious successes:

- detailed preplanning of events (down to the minute in some cases) worked very well in ensuring smooth, transparent transitions from one observation or interaction to another
- students initially were highly engaged (perhaps overly) by the novelty of the approach and high technology in use, although this faded after the second session as the emphasis on the discussion of practice became more central
- other School of Education faculty have expressed an interest in using the technology
- audio quality was very good, and by informed standards the video was better than anticipated
- participants became more comfortable over time communicating via the link (collision frequency decreased and recovery time increased)
- having the initial use of the system include face-to-face videoconferencing with their partners greatly increased student engagement and reduced potential reluctance to communicate

As far as the instructional and institutional goals listed at the outset of this paper are concerned, the pilot met all of the stated goals (at least partially).

Instructionally it:

- provided preservice teachers with the opportunity to observe Ms. Schiller's class relatively unobtrusively (although the amount of that disruption is debatable)
- provided preservice teachers the opportunity to discuss practice with an exemplar teacher
- provided Dr. Gere and her students with a common observational frame of reference upon which to base discussion of teaching methodologies

From the perspective of the institution it:

- helped us gain a better understanding of the capabilities of emerging distance learning technologies and precipitated the gaining of experience with the types of interactions and communication possible in various instructional contexts
- helped us develop a better understanding of the costs (capital and ongoing) and staffing requirements associated with distance learning applications (the ongoing technical support needs in particular are not as low as could be desired)
- precipitated the specification and acquisition of the necessary compliment of equipment, instructional design and technical support required to provide the School with easy access to external environments via mid-cost distance learning equipment
- did not require that we develop an evaluation methodology for determining the efficacy of distance learning implementations (although it is anticipated that the summative evaluation worked being done will address this need)

Naturally, such an ambitious and successful pilot project has inevitably lead to even more ambitious goals (some of which are outlined in the next section). In light of this development, additional funding has been sought from various sources including the U-M Whitaker fund and FIPSE grants.

Next Steps

Briefly, here are some of the applications and improvements that we are intending to investigate as the technology matures and is used by more faculty in support of similar instructional objectives:

- install additional ISDN lines and multiplex them to increase bandwidth available for video as well as to provide for the monitoring of both ends of a connection on-site for troubleshooting and design purposes
- incorporate shared window and whiteboard applications
- incorporate the use of a Visualizer video feed for transmitting object images and scans of grade school work on the fly
- incorporate asynchronous technologies (e.g. web, email) to support offline communication between student pairs
- attempt the inclusion of additional support staff (e.g. graduate students, previous participants) to reduce the cost and strain on current support resources

Cyberspace Needs A Devil
Accreditation for Cyberspace Documents: A Proposal

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Abstract: Locating trustworthy quality information in cyberspace is becoming increasing difficult due to the increase in vanity publishing. Attempts to solve this problem must address the authority of cyberdocuments as well as information retrieval methods. It is proposed that an accrediting agency be created by academic institutions. This agency would provide a quality filter and permit the restriction of information searches to documents that have been accredited. A major advantage would be the ready availability of scholarly information to everyone, not just people with access to a research university libraries. The cost of creating and maintaining such a process could be recovered by the replacement of ever-more expensive paper journals with review e-journals.

The Problem

Education has been defined as a student, a teacher and a book. Distance and networked education in combination with cyberspace resources change the location and definition of "book." Educators need to consider changes in how students locate and retrieve information.

Quality information is vital. As a researcher, I depend upon locating high quality information quickly. As an academic librarian, other people depend upon my help in locating high quality information quickly. Networks and network tools like Archie, Gopher, and Netscape have greatly increased my ability to locate information. However I have noticed that the amount and type of information available over the networks has changed over the last few years, making it harder in several ways to find scholarly information. There is more total information available, therefore it is harder to find any one item of information. There is no overall organization by subject matter. There is an increasing amount of "vanity" publishing going on, especially on the WWW. Other researchers have found these problems too.

The increase in amount of information is not necessarily a critical problem. Organization can overcome volume in cyberspace, just as it can within a major research library. However that organization is not present. Clifford Stoll wrote, "New Internet users often blame themselves for not being able to find information...They don't realize the disorganization of the network is the root of their troubles."[Stoll 1995] Demas, McDonald and Lawrence point out that "what many Internet users are demanding is the kind of selection and organization that libraries have traditionally brought to the world of published information resources."[Demas et al 1995] Michael Gorman confirms this with the observation that "'Surfing' is the process of sifting though this disorganized mess in the hope of coming across some useful fragments of text and images that can be related to other fragments."[Gorman 1995] Clifford Lynch wrote "In short, the Net is not a digital library. But if it is to continue to grow and thrive as a new means of communication, something very much like traditional library services will be needed to organize, access and preserve networked information." [Lynch 1997]

Besides the lack of organization, there is the problem of vanity publishing. One of the problems caused by the increasing numbers of cyberspace users and the increasing ease of publishing in cyberspace is the increasing amount of trivial or erroneous information in cyberspace. Trivial or erroneous information wastes both bandwidth and time. Poor quality documents are not just irritants but time-wasters and therefore money-wasters.

Many of these poor documents in cyberspace are simple vanity items. Formerly the cost of publishing in print on paper served as a partial barrier to vanity publishing. The traditional scholarly communication pattern also served as a barrier through the use of peer review and editorial control. However the cost and the control are not present in cyberspace, except for certain areas.

Publishing used to be an expensive matter. If one wanted to nationally or internationally distribute a flyer or pamphlet, one had to spent a considerable amount of money. The cost of publishing on-line is much lower. Webpages are easy to create and change. This has allowed thousands of people to become their own publisher.

Many of these personal webpages are interesting. However when one is searching for information on-line, these webpages can become time-wasters. Even if a webpage is relevant to a search, the question of authority is unresolved. For most webpages (or even most cyberspace documents), there is no readily apparent means to evaluate the accuracy of the information presented. E-journals share this problem, whether they are peer-reviewed or not. Cyberdocuments lack authority.

Michael Gorman also wrote "Computerization makes quality records easier to use and makes new ways of using them possible; it does not eliminate the need for that quality."[Gorman 1995] Thomas Mann agrees, " If a system makes only *some* sources easily available--especially if those sources are very superficial or of poor quality--then it can do real damage to the quality of research, for it will encourage users simply to make do with whatever sources are *readily retrievable*, regardless of their quality or completeness."[Mann 1993]

Some people wonder if cyberspace is an overblown promise. Robert Raskin wrote, "It's a misinformation highway...The democratization of information means that everyone has the right to be an authority...It's inefficient...With today's proliferation of on-line information, finding what you want is nothing short of a major victory."[Raskin 1994] Other people, like Langdon Winner, argue that these problems should be solved. '"Beyond today's fascination with 'cool sites' lies the need to create tools for inquiry that favor intelligence over confusion and absurd spectacles."[Winner 1995]

Attempted Solutions

One of the main problems of information retrieval is recall versus accuracy. Many information retrieval experts feel that there is a fairly strong reverse relationship between recall and accuracy. That is, as recall increases, relevancy decreases. As recall decreases, relevancy increases.

Recall is the amount of relevant items found as compared with the amount of possibly relevant items. In an uncontrolled system like the Net, it is impossible to know the amount of possibly relevant items. The most usual attempt to increase recall is to broad search strategies.

Accuracy is the relevancy the results. Most items discovered by use of search engines are not very relevant to the user's information need. When confronted by a long list of references, most users do not explore beyond the first 30-35 items.[Wiberley 1995] When search engines produce 50,000+ "relevant" items, users do not usually examine one tenth of one percent. Therefore adding more items from different search engines will probably not improve the relevancy, but it will probable obscure relevant items but placing less relevant items earlier on the list.

There are many attempts to organize or maximize information retrieval processes. Most search engines have many advanced capabilities such as boolean logic. These advanced capabilities require advanced knowledge of the user coupled with continued practice. Unfortunately each search engine seems to have either different capabilities or different syntax for its capabilities. This makes it difficult for a user to be a skilled user of many search engines. However since the databases of different search engines usually seem to be only partially overlapping, some users prefer to use multiple search engines for important searches.

Meta-search engines are being used to allow a search string to be entered at one location, but be searched by many search engines. Since the meta-engines do not permit the use of advanced capabilities, this merely plays to the lowest common denominator. The result is many results, but lower accuracy.

Directories are popular as well. Directories are created by people rather than programs. Each item in a directory should have been reviewed by a person who assigned a subject heading(s). This makes for much more accurate results. The major disadvantage of a directory is the small size, because a directory is very labor intensive.

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Collaborative filtering uses human feedback and profiles to recommend items to a user. This is based on the use of reviews and the concept of community of interest. Two of the better known projects are GroupLens (http://www.cs.umn.edu/Research/GroupLens/grouplens.html) and Firefly (http://www.agentsinc.com/About1.html). These require an adjustment time to create a profile before the collaborative filtering becomes effective. This also filters out "dissenting" or "differing" point-of-views. Firefly describes collaborative filtering as "word-of-mouth on a global scale." A fair comparison might be to Nielsen or Arbitron ratings for information.

OCLC is conducting an Internet Cataloging Project (InterCat). This is an attempt to have professional librarians catalog cyberdocuments to "create, implement, test, and evaluate a searchable database of USMARC format bibliographic records, complete with electronic location and access information for Internet-accessible materials."[OCLC 1996] This is rather like a directory created by librarians. It is a high quality and reliable directory. However it is small when compared with the Net and is constantly shrinking as a percentage of all cyberdocuments. That is, the size of the net is increasing faster than the size of the InterCat (OCLC's NetFirst http://www.oclc.org/oclc/netfirst/netfirst.htm, which includes all InterCat records and more, is adding about 8,000 records a month while the WWW is growing at about one million pages per month).

PICS, Platform for Internet Content Selection (htp://www.w3.org/pub/WWW/PICS/iacwcv2.htm) has established labeling specifications for cyberdocuments. Labels can be assigned by anyone to any document, however a searcher must use the database that holds the labels. These labels can be used for filtering purposes. Currently much of the attention devoted to PICS seems to center on limiting or blocking access for children.

A Proposal

A possible solution lies in a parallel situation. When there were few universities, accreditation did not exist. The few institutions were known to their audiences. Once there were many universities, it became impossible for the average person to know the reputation, orientation, or quality of every or even most institutions. Therefore accreditation arose as a way of certifying a minimum level of quality.

Accreditation is done by a voluntary association. The members of the association have promised to meet certain minimum quality standards. There is an initial inspection to determine that certain minimum levels of quality are being met. Thereafter the individual members of the association are the continual judges of their own quality. However there is also a periodic inspection by a team representing the entire association. This inspection either validates the individual member's judgment of continuing quality or the inspection documents deficiencies that must be corrected for the member to remain in the association, that is, to remain accredited.

Electronic document accreditation could follow the same pattern. A site that desires to have its documents accredited would apply to the association for membership. An inspection team would evaluate the prospective member's documents being put forward for accreditation. If the documents are of satisfactory nature, then the site would be accepted into the association.

The local site would be then responsible for the individual certification of its documents. This certification would be shown by the addition of a trademark (perhaps in a PICS label) to the document. It would be expected that many or most documents would not be certified (such as school calendars, phone books, faculty directories, etc.), only those that are intended as quality, reliable scholarly or educational materials, perhaps at the level one would expect to find in an academic library.

At regular intervals, the association would have an inspection team review a representative number of documents from an accredited site for re-accreditation purposes. If a site lost accreditation, then the trademark would have to be removed from all of the site's documents.

Although the primary advantage to accreditation would be quality assurance of documents in cyberspace, another advantage would be that the trademark could be searchable. This would permit the use of the trademark as a search limiter. That way, someone searching cyberspace would waste less time in information retrieval due to retrieving poor quality documents. Alternately, the search engines could restrict themselves to searching only accredited documents. For example, Lycos (or any other search engine) could offer accredited documents as an optional database for searching.

The obvious mechanism for electronic document accreditation is an association of higher education institutions, although scholarly societies, associations and foundations could also readily be involved. Cyberdocument accreditation would be an additional duty and require additional work for a university, but the benefits to the scholarly community would be great. In fact, if electronic document accreditation is successfully implemented, several accreditation agencies may have to come into existence to cater to specialized needs or subject matters. Fortunately the cost of accreditation visits would be greatly reduced, since the visits could be electronic not geographic. There would also be less cost in preparing reports, since all the material to be evaluated is available in electronic form.

The primary reason for accreditation would be to certify quality by having not just an author, but an association of universities attest to that quality. However this could solve another large problem plaguing higher education. The rising cost of serials has been called the "library doomsday machine" by *Publishers Weekly*. The cost of journal subscriptions has risen greatly over the last two decades. Elsevier (one of the largest science publishers in the world) had a 23.9% price increase for American subscriptions last year. Most university libraries have had to "downsize" their subscriptions over the last ten years.

Electronic journals have been suggested by some as the solution to the increasing serials prices. These e-journals are usually e-mailed to subscribers or placed onto webpages for subscribers to access. However even though some e-journals are peer reviewed, the prestige associated with publishing in an e-journal has remained low. Until the e-journal has more recognized authority, it will remain a less prestigious member of the scholar communication process. Obvious the lower prestige will limit the use and potential of e-journals. However if a university were willing to accredit an e-journal, especially if the university were prestigious, then that e-journal might also acquire a more favorable recognition. This legitimacy could increase the use of e-journals by authors, researchers and students. A shift to e-journals could thus perhaps reduce the scholarly reliance on traditional print-on-paper journals that are rapidly increasing in price.

The creation of an accrediting association would be difficult, but if done successfully would confer great prestige and recognition on the initial innovators. Quality assurance of documents would be of world-wide interest and impact. Legitimacy of e-journals could reduce the costs of research and scholarly communication.

Why does cyberspace need a devil? Accreditation has almost always been controversial. In 1939 Samuel P. Capen delivered a speech against accreditation entitled "Seven Devils in Exchange for One." The speech was on the exchange of local control for accreditation. Perhaps the devil of electronic document accreditation is a preferable choice to the deep blue sea of vanity publishing in cyberspace?

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Situated Model-Based Development of Interactive Study Systems

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Abstract

The development of educational software is a difficult and time consuming task. One of the main reasons is that design methods seldom fit to a specific design problem and therefore developers rarely use these methods. We describe the 'Situated Model-Based Development Approach of Educational Software' as a possible answer to this unfit. Situated means here that this approach enables developers to set up a design approach for individual educational software design problems. A resulting design approach is tuned to characteristics of an initial design problem and project context. Model-Based means here that we see models as tentative solutions to educational software design problems. We expect that the application of this approach will lead to less difficult and less time consuming development of educational software. In addition we expect that research on this approach will help us to gain further insight into design issues of educational software.

Introduction

The development of educational software is a difficult and time consuming task, although developers of such systems have at their disposal a variety of design methods, authoring tools and environments. One of the main reasons is that developers of educational software still see the development process mainly as a creative ones, in which existing design methodologies only offer limited support and therefore are rarely used. As a result however, development processes are difficult to manage and resulting educational software lacks, for instance, quality, opportunities for maintenance, and re-use of software parts.

The field of Software Engineering encountered similar problems while developing information systems. An answer was found in a development approach named 'Situated Model-Based Development of Information Systems'. We think that this approach can also be applied to the development of educational software. In this paper we describe an example of a Situated Model-Based Development Approach. We will not describe however extended rationales behind this approach. These rationales are discussed in more detail by, for instance, Harmsen, Brinkkemper, & Oei (1994), van Slooten (1995), and Lemmen, Brinkkemper, & van der Veen (In preparation). Finally, we discuss implications of applying such an approach for the development of educational software and for design aspects of this software.

To make our discussion more concrete, we want to restrict it to a specific type of educational software. Educational software refers to a variety of software products, names of which are composed of several subconcepts referring, for instance, to:

- an interesting aspect of a product, such as: Interactive, Flexible, Integrated, Performance, Multimedia, Distance, Telecommunication, Virtual;

- an educational aspect of a product, such as: Assisted, Learning, Training, Support, Instruction, Training, Study, Course, Classroom, Education;
- a software or hardware aspect of a product, such as: Tool, Program, System, Environment, Card, Computer, Network.

Names are for example an Interactive Learning Program or a Virtual Course Network.

The specific type of educational software we refer to is named Interactive Study System (ISS) (de Vries, Vogel & Brinkkemper, 1997). Interactive is stressed, because we consider interaction as one of the main advantages of the use of computers for instructional purposes. Study is meant in the sense of 'to spend time in learning' and also in the sense of 'a room used for studying and working'. We want to emphasize flexibility of users in the study process while 'spending time in learning in the interactive room'. A study process can be described as an interaction process among a teacher(s), a student(s), and information content, which process is mediated by an ISS. System refers to a software product meant for a specific set of user tasks, for instance a word processor or a spreadsheet. Basically we see an ISS as a software system consisting of study tools, educational resources, and if needed additional materials. An ISS can be extended by generic software tools, like communication and information editing tools. Study tools can vary from drill and practice tools, tutorial tools, simulation tools, concept mapping tools, study workplaces, etc. Study tools are software tools that are particularly designed to enhance individual or group-based study processes. Educational resources refer to the multimedia information content matter. Additional materials refer to information and/or tools that support study processes but which are not offered in an electronic way. Generic software tools are tools that are not particularly designed to enhance study processes. Examples of such tools are communication and information editing tools. Communication tools can be used to enable communication among students, among student(s) and instructional managers, and information providers, etc. Information editing tools can be used to edit documents, spreadsheets, tables, e.g. The main goal of an ISS is to enable an interactive study process between a user of the system and other users and/or between a user(s) and educational resources.

In this paper, we present a Situated Model-Based Development Approach of ISS's . 'Situated means here that this development approach enables developers to set up a design approach for individual ISS design problems. A resulting design approach is tuned to characteristics of an initial design problem and project context. 'Model-Based' means here that we see models as tentative solutions to ISS design problems.

Situated Development of Interactive Study Systems

The Situated Model-Based Development Approach we apply in this paper is based on Lemmen & Punter (1994a & 1994b). Their approach is meant for the design of Information Systems. We have transferred and simplified their approach in order to apply it to the design of ISS's. This transferred and simplified model is presented in Fig. 1.

A framework for modelling ISS's is the core of this Situated Model-Based Development Approach. Several approaches are used in Software Engineering in order to represent information systems. The approach Lemmen & Punter have chosen, is MADIS, a Modelling Approach for Designing Information Systems (Essink, 1986; Essink, 1988). The leading idea behind this approach is that modelling of information systems always takes place on different levels of abstraction, but on each level the same modelling aspects come up. According to Lemmen, Brinkkemper & van der Veen (In preparation) as this approach is based on experiences in a variety of design projects, the resulting framework is very compact and complete. As ISS's can be regarded as a specific type of information systems, we think that the MADIS approach is applicable to modelling of ISS's.

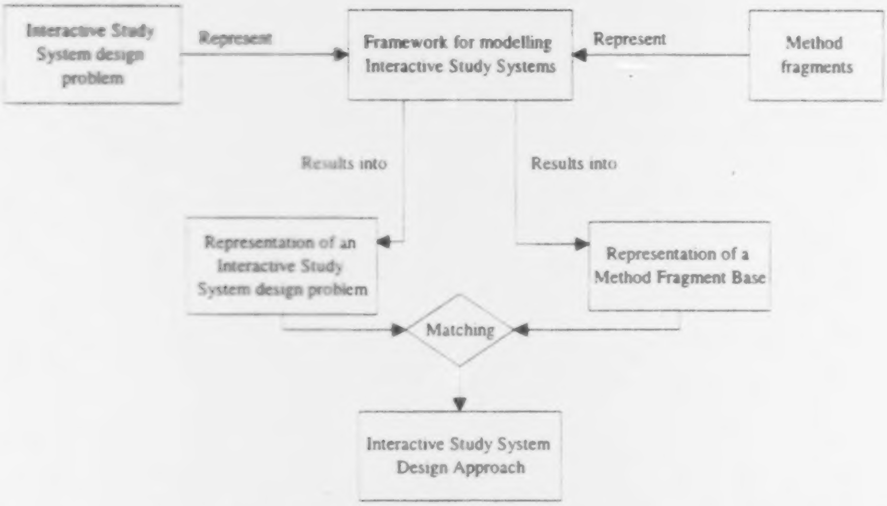
Interactive Study System design problem
Represent
Framework for modelling Interactive Study Systems
Represent
Method fragments
Results into
Results into
Representation of an Interactive Study System design problem
Representation of a Method Fragment Base
Matching
Interactive Study System Design Approach

Figure 1 Situated Model-Based Development Approach for Interactive Study Systems

It has been already mentioned, MADIS deals with modelling levels and aspects. There are four modelling levels identified: the object system modelling level, the conceptual interactive study system modelling level, the data system modelling level, and the implementation modelling level.

- The object system modelling (OSM) level is the level where a description of that part of an organisation for which an ISS should be designed and realised is given. Such an organisational part can, for example, be a Training Department of a large company. This department provides employees with continuing training opportunities by applying ISS's in order to enable them to study at home using the Internet.
- The conceptual interactive study system modelling (CISM) level is the level where the ISS is viewed as a set of (functional) components, which enables the users to attain the study goals. In the example of a Training Department such an ISS can consist of several components. An employee at home may have an Employee Student Study System including Internet Communication Tools. A Training Department may have an Educational WebSite consisting of Training Information Content and on-line educational support tools.
- The data system modelling (DSM) is the level where an ISS is considered to be a data processing system. The main issue here is how an ISS works. In our example a description is given, for instance, of the Training Information Content, the intended communication procedures between the WebSite and employees, and the intended study interaction processes.
- The implementation modelling (IPM) level is the level where an ISS is viewed as a concrete, operative and maintainable system, which has to be developed, used, and maintained in a user context, for instance, at a Training Department and at homes of employees. An implementation model can be viewed as a blueprint of a yet to be developed ISS. In our example choices have to be made for instance for a specific WebBrowser, database system, study tools, and hardware configurations.

At each modelling level a distinction is made among eight modelling aspects. These aspects are: Goal structure, Environmental interaction, Functional structure, Entity structure, Process structure, System dynamics, Allocation aspect, and Realisation aspect. Each aspect can be considered as a modelling view on ISS's.

- A goal structure view implies that an ISS is an organised set of elements and relationships between them, directed at the realisation of a set of study goals.
- An environmental interaction view implies that most ISS's have a dynamic reality whereby external active elements have an impact on these systems because of their behaviour.
- A functional structure view implies that an ISS can be decomposed into subsystems or modules until a level of decomposition is reached at which, in terms of the problem at hand, it is no longer meaningful to identify smaller modules.

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- An entity structure view implies that an ISS can be decomposed into relevant entities, their properties, and their relationships. Entities can be viewed as passive elements in a system whose status is a result of the behaviour of active modules determined in the functional structure.
- A process structure view implies that an ISS has a structure and a process. In each functional module processes take place as part of the study process as well as of the management process of the ISS.
- A system dynamics' view implies that the behaviour of the ISS should be specified in a time dimension in order to be able to verify how it corresponds with the reality.
- An allocation view implies that there is a need for matching personnel and equipment with the requirements and demands, which are needed to perform the study processes in the organisation. In other words, a design of a ISS is not complete without results of an organisational and technical feasibility analysis.
- A realisation view implies that an overview of consequences of a design process is needed in terms of personnel, equipment, software, etc. Its main purpose is to reveal the demands that a design of an ISS puts on an organisation.

Taking into consideration, this description of levels and aspects it is possible to set up a framework for modelling ISS. This framework is presented in Fig. 2.

	Goal-structure	Environmental interaction	Functional structure	Entity structure	Process structure	System dynamics	Allocation aspect	Realisation aspect
OSM								
CISM								
DSM								
IPM								

Figure 2 **A framework for modelling Interactive Study Systems**

Each element of the framework describes a modelling area using an aspect of an ISS on a certain modelling level. We assume here that these 32 elements give a rather complete overview of relevant ISS-modelling areas. The description consists of modelling specifications, basically of modelling questions. Modelling questions for the element OSM/Goal structure are for instance: What are the goals of the organisation in which the intended ISS is going to be used and what is the desired contribution of the intended ISS to the attainment of these goals? Answering all the relevant modelling questions on a specific ISS should eventually lead to an actual model of that ISS, which should be looked upon at a tentative solution to the initial ISS design problem.

However, in order to answer all such questions, there is a need for design methods, techniques and instruments. To meet this need, Lemmen & Punter use the concept Method fragments. Method fragments are design methods and/or techniques stemming from existing information system design methodologies, which are applicable in generic partial design problems. Lemmen & Punter assume that all such method fragments can be represented in the framework for modelling information systems. The result of this representation is a Method Fragment Base, which is a database filled with method fragments, structured according to the framework for modelling information systems. Instead of information systems, we speak of ISS's. That implies that based on the presented framework for modelling ISS's, we have to represent method fragments stemming from educational software design methodologies in order to realise an Method Fragment Base for ISS's.

This Method Fragment Base can be used as a source for method fragments. This can be done by representing an initial ISS design problem on the framework for modelling Interactive Study Systems. This implies that an initial problem is splitted upto modelling areas. For each modelling area a choice has to be made for one or more method fragments. This process of deriving and fine-tuning of appropriate fragments is called Matching. The result of Matching is a Situated Interactive Study System Design Approach. It is situated, because the fragments chosen are based on characteristics of the initial ISS design problem. The approach is model-based because the final results of this approach are tentative models of the intended ISS. The whole approach is adaptable. For instance, developers can add their own modelling aspects, modelling questions or method fragments to the approach.

The above description of a Situated Model-Based Development Approach for ISS's is simple, as only the main ideas behind this approach are outlined. An important issue in our further research is

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to reconsider the modelling aspects and to conceptualize educational software modelling aspects. We are for instance transforming characteristics of educational software – such as quality and practicality of use -- which are held responsible for the succes of implementation of educational software in curricula into such aspects.

Discussion

The final issue to be adressed here is, may we expect that application of this Situated Model-Based Development Approach for ISS's leads to less difficult and less time consuming development of such systems?

We consider two reasons to expect that an answer to this question is of positive nature. First, this approach forces developers of ISS's to think of and to construct a design approach in the earlier stages of a development process and the resulting approach is expected to fit to characteristics of the initial ISS design problem and project context. Secondly, this approach provides designers with appropriate design experiences. The framework for modelling ISS's can be considered as an ISS Knowledge Base and a Method Fragment Base as a Design Knowledge Base. Adaptation of both, the framework and the Method Fragment Base, makes it possible to continuously accumulate experience. As a result the development of ISS's is expected to become less difficult and time consuming.

However a less difficult and time consuming development of ISS's is not the only promise of applying this Situated Model-Based Development Approach. We think that research on this approach will help us to gain insight into design of ISS's and therefore educational software in general. Elaboration on the eight modelling aspects is one of the research issues. A further specification of, for instance, modelling questions for all four modelling levels will help us to improve our understanding of relevant design aspects of ISS's. Another research issue to be considered is the Method Fragment Base for ISS's. Creating such a base implies a thorough analysis of the relevance of methodologies to the design of ISS's. Representing existing method fragments onto the framework for modelling ISS's will lead, for instance, to insight in the omission or inadequacy of fragments for specific modelling area's. We think that further research into this Situated Model-Based Development Approach of ISS's will lead to a growing insight in the design (product and process) of educational software.

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Design of an Educational Hypermedia Application Using the Labyrinth Formal Model

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Abstract. In this article we present the design of HyperMed, an educational hypermedia application conceived to teach undergraduate medicine students, using the Labyrinth formal model whose main advantages are the inclusion of users modelling and the possibility of defining generalised structures and security policies. HyperMed allows students to treat a series of "patients" presenting different symptoms. The characteristics of the model and the functionality of the educational application are briefly exposed, the design of the application is outlined and the conclusions derived from this experience are also presented

Introduction

Hypermedia systems differ from other software applications in critical issues, such as the inclusion of different kinds of reactive and dynamic information and their sophisticated behaviour in navigation. Due to these special features, traditional design models and methodologies are not well suited for hypermedia design [Fuller et al. 1992; Garzotto et al. 1993] and for this reason dedicated formal models have been developed. Trellis [Stotts and Furuta 1989a,b] for hypertext and Dexter/Amsterdam [Halasz and Schwartz 1990; Hardman et al. 1993] for hypermedia systems are widely diffused ones. Although these models fulfil hypermedia requirements, like structure-content distinction, definition of anchors and composite elements, time-based relations, etc., important issues still remain not addressed. For example, in Trellis, virtual anchors and links to represent semantic relationships are not included; aggregation and generalisation relationship are not modelled and mechanisms to guarantee information integrity cannot be defined. Dexter/Amsterdam do not allow dangling links nor links representing different semantic relationships; generalisations can not be defined; conditional synchronisations for multimedia information are not allowed and security mechanisms cannot be modelled.

Labyrinth [Díaz et al. 1996a] is an abstract model that do fulfil the above mentioned requirements as well as those of the third generation of hypermedia systems described in [Halasz 1988]. The most salient features of Labyrinth are:

- It makes a clear distinction between the abstract containers that make up the hyperdocument structure (modelled by means of the nodes) and the information items (modelled by means of the contents).
- Link and anchor definitions allow several types of uni- or bi-directional links to be defined. Dangling, virtual and context links as well as semantically different relations can also be defined.
- Composite nodes are used to represent the generalisation and aggregation abstractions defined in [Garg 1988] by means of multitarget links. Both mechanisms define composite nodes that structure the system on a logical and operational level. Aggregation composite nodes allow to refer to a group of nodes by means of a unique identifier, regardless of the properties of the nodes. Generalisation composite nodes provides a means to represent a set of nodes sharing at least one hereditary

characteristic. Common characteristics are defined in the composite node and are inherited by each generalised node. Complex structures can be represented by nesting several composition levels.

- The definition of temporal dimensions in Labyrinth permits multimedia information and timing to be explicitly treated. Events are defined as expressions that state the conditions under which a series of actions are triggered.
- Different access mechanisms such as queries or browsers can be defined.
- Labyrinth allows users to define personalisations by adapting the contents and the structure of the hypermedia net to their needs and preferences. Personalisations do not affect the basic document and are visible only to their owners (groups or individual users).
- Two security mechanisms are included: a discretionary mechanism preserves information confidentiality while a mandatory one, based on classic flow information models, ensures information integrity.
- Elements for version control are provided, allowing unlimited version sequences of nodes and contents to be maintained.

In this article, we present an example of the use of Labyrinth for the design of generalisations in hypermedia structures and the definition of security policies, by describing the design of an educational hypermedia application, conceived to teach undergraduate medicine students. Only the model components used in this example are formally defined here.

The Labyrinth model

In Labyrinth, a hyperdocument is defined as the union of a "Basic Hyperdocument" and a series of "Personalised Hyperdocuments", each of them belonging to a user or group of users. In a personalised hyperdocument, users can either modify components of the "Basic Hyperdocument" adapting them to their own necessities or create new ones. The "Basic Hyperdocument" consists of the following 11-tuple:

$$< U, N, C, A, L, B, E, lo, al, el, ac >$$

where "U", "N", "C, "A", "L", "B" and "E" are respectively sets of Users, Nodes, Contents, Anchors, Links, attriButes and Events and "lo", "al", "el" and "ac" are functions. "lo" determines the location of a content into a node, "al", "el" and "ac" get the list of attributes, the list of events and the access category of an element respectively. In addition, each user or users group can have a "Personalised Hyperdocument," that is defined using the following 10-tuple:

$$< UserId, N^P, C^P, A^P, L^P, B^P, E^P, lo^P, al^P, el^P >$$

where "UserId" is the User identifier indicating the owner of the personalisation (group or individual) and the remaining items are personalisations of some items defined in the Basic Hyperdocument tuple. "N^P", "C^P", "A^P", "L^P", "B^P" and "E^P" are either composed by new elements or modifications of the corresponding components of the Basic Hyperdocument. "lo^P", "al^P" and "el^P" are also composed by new or modified functions.

The formal definition of some of the model components and, in particular, those used in the example of the next section, are included in [Tab. 1] .

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$U = \{U_i \mid i = 0,\ldots, n, n \in N, \text{ where } U_i = (UserId_i, UserType_i, UsersList_i)\}$	
$UserId_i$:	$UserId_i \in$ {alphanumeric string}
$UserType_i$:	$UserType_i \in$ {group, individual}
$UsersList_i$:	$UsersList_i = \{UserId_j \mid i = 0,\ldots, m, m \in N\}$ represents: list of the members of the group if $UserType_i$ = group list of the groups to which UserIdi belongs if $UserType_i$ = individual
$A = \{A_i \mid i = 0,\ldots n, n \in N \text{ where } A_i = (AnchorId_i, NodeId_i, ContentId_i, AnchorPos_i)\}$	
$AnchorId_i$:	$AnchorId_i \in$ {alphanumeric strings}
$NodeId_i$:	$NodeId_i = -1 \cup \{NodeId_j \mid \exists N_j \in N, NodeId_j \in N_j\ j = 0,1,\ldots,n, n \in N\}$ $NodeId_i = -1 \Rightarrow$ anchor is tied to a content
$ContentId_i$:	$ContentId_i = -1 \cup \{ContentId_j \mid \exists C_j \in C\ ContentId_j \in C_j\ j = 0,1,\ldots,n, n \in N\}$ $ContentId_i = -1 \Rightarrow$ anchor is tied to the whole node If both $NodeId_i$ and $ContentId_i \neq -1$ the anchor is referred to the content only when the content is associated to that node
$AnchorPos_i$:	$AnchorPos_i = \{Position_i, Extension_i\}$ $Position_i$ = Location of the initial point of the anchor in the node or content $Extension_i$ = Extension of the anchor into the node or content $Position_i$, $Extension_i$ take values in units of the node or content dimensions
$L = \{L_i \mid i = 0,\ldots,n, n \in N \text{ where } L_i = (LinkId_i, LinkStart_i, LinkTarget_i)\}$	
$LinkId_i$:	$LinkId_i \in$ {alphanumeric strings}
$LinkStart_i$:	$LinkStart_i = \{AnchorId_{ij} \mid \exists A_j \in A, AnchorId_{ij} \in A_j, j = 0,1,\ldots,n, n \in N\}$
$LinkTarget_i$:	$LinkTarget_i = \{AnchorId_{ij} \mid \exists A_j \in A, AnchorId_{ij} \in A_j, j = 0,\ldots,q, q \in N\}$
$al\colon \forall x \in (U \cup N \cup C \cup L), al(x) = \{AttributeName_i, Value_i\}, i = 0,\ldots,n, n \in N$	
	$AttributeName_i \in B_i$
$ac\colon \forall U_i \in U, \forall x \in (N \cup C), ac(U_i, x) = AccessCategory_i$	
$AccessCategory_i$:	$AccessCategory_i$ = {0, browsing, personalising, editing} 0 ⇒ access denied browsing ⇒ the user can visit the content/node personalising ⇒ the user can personalise the content/node editing ⇒ the user can modify the content/node

Table 1: Labyrinth elements (N is the set of natural numbers). Alphanumeric strings used as identifiers can not be repeated

HyperMed Design

In this section, we present the HyperMed application, then, its design and, finally, the advantages of the Labyrinth model use are shown. The most relevant benefits of using the model can be summarised as the potentiality of:

- defining types of users depending on their roles and abilities;
- specifying the application structure from a logical point of view, and
- defining a security policy during the design stage.

Application Description

HyperMed is an educational tool intended to help undergraduate medicine students to analyse real cases. With this purpose, students, who are supervised by teachers, will be able to treat a series of "patients" who present

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different symptoms. Every patient has a card with his/her clinical history (symptoms, treatment, tests' results and other relevant data). For each type of test, all data are held in order to study the reaction of the patient to a particular treatment.

HyperMed students are organised in groups. Each group is concerned with a medical speciality, and it takes care of its own patients. Group members can discuss and take decisions about a treatment, as well as modify the card of a patient. In order to identify a pathology or treatment, students can inspect a common theoretic repository where information for each illness is provided. In addition, students can consult but not modify the patient cards which belong to other groups, since they can not take part in their treatment.

Teachers are responsible for students' groups, and, therefore, each teacher can browse and add notes to the cases treated by the members of the group he is surveying. They can also modify the contents of the theoretical repository.

HyperMed is conceived as a hypermedia system. A hypertextual structure is used to provide a direct access to related terms and concepts. Multimedia contents, like text (e.g. blood analysis), images (e.g., radiography), video (e.g., colonoscopy) and sound (e.g., pulse), are used to enrich the information about patients and pathologies.

Design Description

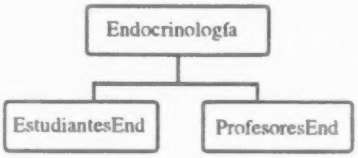
Labyrinth has been used to carry out the design of HyperMed which has been divided into the following tasks:

- Definition of users
- Definition of the hyperdocument structure
- Inclusion of contents
- Definition of the security policy

The use of the model in each task is described below, highlighting those aspects for which Labyrinth was found more useful. A graphical representation of the model components is used in some tasks to illustrate the formal definition.

Definition of the Users. From the description of the application, the existence of different kinds of users, with distinct abilities to manipulate information, emerges as an essential characteristic of the system. Labyrinth users provide a formal way to specify this characteristic during the design stage.

In particular, two different groups of users are considered for each medical speciality: students and teachers. Constraints are not imposed on the groups definition and, therefore, individual users can take part in different specialities and play different roles depending on the group they are included. For example, [Fig. 1] shows the definition of the users' groups for the "Endocrinología" speciality.



```
("Endocrinología", group, {"EstudiantesEnd","ProfesoresEnd"})
("EstudiantesEnd",group,{StudentEnd1,...,StudentEndN})
    where StudentEndI (I=1,...,N) is defined as an individual user
("ProfesoresEnd",group,{TeacherEnd1,...,TeacherEndN})
    where TeacherEndI (I=1,...,N) is defined as an individual user
```

Figure 1: Example of users definition

Each group of users is assigned an ability to manipulate the hyperdocument in the definition of the security policy.

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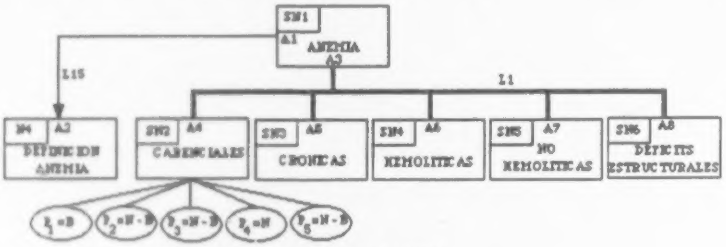
Definition of the Hyperdocument structure. The information of HyperMed, can be conceptually organised using hierarchical structures with or without heritage of characteristics. Aggregation and generalisation mechanisms provided by Labyrinth can be quite useful to define the structural components of the system. In this task, a network of nodes and composite nodes, connected by aggregation and generalisation links, is used to conceptually define the system structure. In addition, referential links are used to define navigation paths.

For example, [Fig. 2] shows an example of the structure corresponding to the "Anemia" pathology included in the theoretical repository. In the figure, the different kinds of this pathology (e.g. nutritional, haemolytic, aplastic..) are generalised by means of a composite node (SN1) and the general link L1. The general node includes a referential link to the definition of this illness (L15) which will be inherited by all the generalised nodes. Other elements included in this structure are the attributes (PI) which add semantic information to the elements. For example P1 represents low levels of red blood cells which constitutes a symptom of nutritional anaemia.



(L1,{A3}, {A4, A5, A6, A7, A8})
AL(L1)={(Direction, bi),{TypeLink,General)...}
(A3,SN1,-1,(-1,-1))
(A4,SN2,-1,(-1,-1))
(A3,SN3,-1,(-1,-1))
(A3,SN4,-1,(-1,-1))
(A3,SN5",-1,(-1,-1))

Figure 2: Hyperdocument structure example

Inclusion of the Contents. The hyperdocument structure is thoroughly specified by defining the contents that are included in each node and composite node. Contents are placed in the spatial and temporal axis of nodes and composites. Synchronisations and space-based relationships are also defined among contents.

Definition of security policy. The security policy is defined by means of the security labels provided by the Labyrinth model, whose value can be set to "editing", "browsing" or "personalising".

Users defined in the first task are assigned a security label which determine their ability to manipulate the system elements. For each medical speciality, teachers are allowed to modify the theoretic contents and to browse and add comments to the student works. For example, the value of the access function ("ac") of "ProfesoresEnd" and node "PacienteEndocrino" in [Fig. 3] is set to "personalising", so that a teacher of this group is avoided to edit the contents of this node, whereas they have an "editing" category for the node "DefiniciónCarencial" which represents an entry of the theoretical repository. Students can personalise and modify the cards of their patients (see the value assigned to the group "EstudiantesEnd" for the node "PacienteEndocrino"). Moreover, all students are allowed to browse the theoretical contents and the patient cards belonging to other groups.

ac ("ProfesoresEnd", "PacienteEndocrino",personalising)
ac ("ProfesoresEnd", "DefiniciónCarencial", editing)
ac ("EstudiantesEnd","PacienteEndocrino",editing)
where:
"PacienteEndocrino" represents the card of a patient who presents anaemia symptoms

Figure 3: Example of security policy specification

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Security labels are also tied to nodes, composite nodes and contents to restrict the operations which can be performed over them. Most of them have an "editing" category which will can be constrained by testing the user's category.

Conclusions

A number of advantages have been derived from the use of the Labyrinth model in the design of HyperMed, in agreement with previous experiences in the design of applications with this model [Díaz and Aedo 1996].

The most important conclusion is that the use of Labyrinth allows to unambiguously define the system, providing a communication channel between the different members of the development team. In particular, the definition of user groups, the hyperdocument structure and security requirements during the design stage, have been found quite useful to reduce unexpected problems and requirements.

The output of the design phase has been a clear hypertextual structure where aggregations and generalisations were used to organise hierarchical trees of illnesses. In addition, the distinction between contents and nodes allowed to avoid duplication of documents and redundancy of information. The roles and abilities of the users were defined by means of the mandatory security policies included in Labyrinth. The use of version links permitted to maintain the sequences of tests in ordet to analyse the evolution of the symptoms.

Although the up to now experiences are very encouraging, the limited number of applications designed with Labyrinth does not permit a precise evaluation of the capabilities and limits of the model. With this purpose, the design of more complex hypermedia applications for distributed and collaborative environments is needed.

Moreover, two factors, the design quality (in terms of accuracy and comprehensiveness) and the time required to complete it, were shown to be strongly dependent on the skills and previous knowledge of the designer about hypermedia systems and models. To solve this weakness a detailed design methodology is required and, in fact, it is already under development [Díaz et al. 1996b].

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Problem Based Learning:
A Means to Evaluate Multimedia Courseware in Science and Technology in Society

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Abstract: Multimedia learning materials for the grade 11 and 12 chemistry curriculum of Alberta were developed which included links from the core materials to special issues in science technology and society. This study took six grade eleven students two teachers, two researchers, a representative of the environmental alliance of Alberta and the resources of the internet. A problem based learning approach was used and students had to answer the question 'What do the citizens of Calgary need to know about the safe transportation of chlorine through the city?'. The study revealed difficulties of using current web tools for problem based learning and argues for a specific architecture to support this style of learning for a future design.

Introduction

Learning in the classroom has and will continue to become more the responsibility of the learner. The distributed nature of electronic materials available from the internet creates a challenge especially for unpractised learners to manage and make sense of. At another extreme of instructional design in practice, author—paced tutorials do not support the kinds of explorations which are arguably more relevant to social and environmental issues. This study is motivated by a belief that socio—scientific literacy must be grounded on well understood core scientific knowledge. A measure of socio—scientific literacy might be the extent to which a reader can make well reasoned reactions to issues which require a scientific understanding when reported for example by the local media. The study is also motivated by the idea that such issues grounded in the experiences of all of us can motivate learning of the core elements in a science curriculum at the same time. Problem based learning (Duffy & Jonnassen, 1992) seems a likely solution to the challenge of a highly distributed and un—moderated resource base. Some evidence suggests that high levels of intellectual maturity and metacognitive abilities are required by students to benefit from problem based learning (Gallagher, 1992) however for those students who have not yet developed such skills some scaffolding devices may be necessary. The central role of this study is to test and provide design guidelines for multimedia software which was initially designed to be delivered by compact disk but which will in a new incarnation take account of related materials available from the internet and may itself become distributed. This study actively engages eleventh grade students in the solution of a problem designed to provide a motivating and challenging task and thereby to accomplish goals in the Alberta education curriculum. Sometimes the value of problem—based or enquiry methods tend to look at the development of skills in areas other than the discipline being taught such as critical thinking skills (Duffy & Jonnassen, 1992). This study assumes that those skills do improve through adoption of such approaches however the experiment is focused on the goals of science technology and society and the connections to the formal chemistry materials.

The study shows that using web based materials combined with the various search mechanisms proved an enormous overhead for students. The process of solving the problem was difficult as was the change to a facilitative orientation by the supporting instructor. Recommendations are made which should help alleviate the difficulties of problem based learning, to relatively seamlessly integrate socio—scientific literacy goals with formal chemistry, and, to make the interface do some of the facilitative work for the instructor. These recommendations are based on providing the inherent guidance of a fixed set of formal schema linking rhetorical and socio—scientific structures within an instructional design framework. This kind of system will enable generalisable problem solving in a constrained environment and provide the necessary systematicity to later add agent support. It will ease the process of writing courses for the author and make exploring chemistry and the links with its social implications less of an overhead for the student.

Another approach to evaluation.

This study represents a novel and challenging approach to evaluation in a continuously developing suite of evaluation processes and instrument development (Ross & Morrison, 1992; Dobson, 1994; Dobson & McCracken, 1997). In this case we are concerned with objectives based on: a) assisting the continued development of a software product, b) assessing learned outcomes in an area of formal chemistry, c) assessing development of skills related to socio—scientific literacy, and, d) evaluating the use of a problem based learning process as catalyst to all the above.

This study proved interesting in many respects including the development of facilitation skills by the tutor, development of problem based learning skills in the students and in the reactions learners and students had to the multimedia materials. Rhetorical structures of standard argument such as justification and evidence finding are bolstered by systematic approaches such as cost—benefit analysis, risk—calculation and reduction. Information processing at many levels is required in the apprehension of socio—literate skills. Even before the difficult process of assembling an argument or a problem solution simple acts of information sorting, pruning, discarding, prioritisation have to be carefully undergone. In the formulation of a final product a well reasoned response to an issue of science technology and society must be coherent, non—contradictory and generally sound in at least some informal way. All these skills are known to be difficult in well constrained domains such as physics (Simon, 1992; Van Lehn, 1991), and in less formal domains the problem may be more intransigent since argument is embedded in natural language. The science technology and society curriculum exists in the realm of informal social discourse but provides scope for the use of scientific and well defined justification for a discourse position.

Students of the level used in this study cannot be assumed to have developed the metacognitive skills required by researchers in monitoring their own learning (O'Malley, 1990). Problem solving is done differently by those who are practised at the skill of general problem solving (Chi & Glaser, 1985) than those who have not previously been successful. With such difficulty in both the process of self monitored learning and in problem solving for novices it might seem strange that a problem based approach to learning is considered a worthy constructivist model for the classroom. However inherent in the ambitions of constructivism generally is the added goal of a separate learning objective. Beyond learning the chemistry material a constructivist approach also aspires to students improving general metacognitive skills. The result of such a change in the goals of a curriculum alters the way in which learning interactions may be reasonably evaluated. No longer may we test students in the domain before a learning interaction then after and see the difference as equivalent to the only learning gains. It is often said that changes in the student's ability to learn the material under their own control should also be considered in an evaluation. Problem solving because of a clear sense for the solver of the end goal and because states of the problem solving process can be measured against the final solution can give the learner a very clear sense of progress and provide the information a learner needs to monitor their own successes.

This approach to evaluation castes distributed multimedia materials in the best light possible by creating an interaction style most likely to promote learning outcomes. The evaluation hi—lights difficulties with implementing problem based learning both for the student and the instructor. The approach is demanding of all parties involved which is more of a reflection on the technology we have so far been able to develop than on developmental problems of students.

A problem based study

The study used six eleventh grade students from a secondary school chemistry class who came to the offices of the Alberta Research Council in Calgary Alberta. Problem based learning as it has come to be thought of in current teaching organisations almost exclusively assumes a group project based practice. This study does not argue with that assumption although the chief value of the group approach for us was to provide externalisation of the problem solving processes to yield usable data to answer the evaluation questions.

Prior to the study each of the students had been introduced to the software program Chemistry—20 and had looked at material relevant to the problem to be solved. This gave the students experience at interacting with the interface which Chemistry—20 uses. Access to materials used in the study was moderated to help track what was used and to provide a range of interaction. Materials included: a) all documents available by internet, b) search engines plus support in how to use them, c) film footage of a train spillage, d) newspaper clips of similar disasters, and, e) a collection of pre—selected text books. As well as the six students in the room the study was supported and at times observed by: a) the class teacher, b) one of the researchers (collecting video data), c) the

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software development director, d) the facilitator, and, e) a local environmental and chemical industry expert. These individuals had well defined roles for the experiment since the tenets of a problem based approach are quite clear and the roles which most of these individuals are used to playing are quite different. Teachers for example are more used to teaching than to facilitating and this number of supporting individuals would be very unusual in a normal classroom using a problem based approach. We recognised particular interests of the industry representative and moderated student's access to him by locating him in a separated office. The facilitator had little previous experience in facilitation although had conducted project work with his class in similar issues using a range of rhetorical support including cost—benefit analysis. The facilitator had reviewed materials outlining good practice as a facilitator the central tenets of which adapted from (Duffy, 1994) are worth reproducing here:

1) monitor phases of problem solving ensuring the proper sequence of phases and that proper attention is given to each phase;
2) probe students knowledge deeply;
3) involve all students in the group process;
4) make educational diagnosis by attending to problems in reasoning and understanding and in finding information;
5) probe a student in an area where you think he is having difficulty;
6) ask the student to reflect on his understanding;
7) modulate the flow of the process by making sure things don't progress too slowly or too quickly;
8) manage interpersonal dynamics, once they get to know one another group dynamics can soon break down and hostilities arise;
9) let students notice a problem if possible and help them deal with it and call for resolution as an out of class activity;
10) play a metacognitive role: refraining from giving information, from evaluating responses or input, and, by actively providing questions that challenge the student as often when right as when wrong, and finally,
11) wean oneself from the situation and support the students when they begin taking on the role you are playing and hence can function as independent learners.

The director of software development and co-ordinator for the study introduced students to other participants and held a short debriefing after the study was complete. The class teacher's role was to provide affective support and specific chemistry guidance should things go badly. The researcher's role was in data collection. The students role was to solve a problem and we had designed this problem so as to provide a good chance of solution and of making the connection between the formal chemistry and the socio—scientific issues which surround it. The problem eventually settled on was: "What do the citizens of Calgary need to know about the risk to the environment and society's safety as a result of a train derailment involving the chemical Chlorine?" The student's task was to produce a 'flyer' that answered the problem and communicated their findings to the citizens of Calgary. This flyer would later be distributed with a copy of the local daily newspaper to the homes of many thousands of people. Video data was collected throughout the day with a video camera located in the home room and notes collected by the principle observer both from first hand observation and by group interview.

General Observations

The facilitation role was not well understood to begin with and although the teacher charged with this role was supportive he spent a lot of time not engaged in solving the problem with the students. After direction he became more actively involved in the process until at the end of the day his report back to the debriefing group showed just how much he had learned about problem solving in learning and the role he had developed. This result is very encouraging. With relatively little preparation over the course of just one single day a teacher used to an expertise delivery model developed substantial understanding and practice.

Table 1. Showing time spent in research and proportion of material used in intermediate product.

	Time—source	User—product
Experts face—to—face	10	30
Books	12	10
Books directed by experts	45	40
Web pages (assisted)	30	5

Note: Figures are in percentage of total time in the study whilst at the study site and relevance to product.

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We were surprised to find that the most productive interaction with the available resources came from the experts in the study. The resources that were used most in the study were those provided or directed to by the environment and industry experts. The most inefficient means of information retrieval which took place was time spent accessing web pages through search mechanisms.

Socio—scientific issues are very real issues with real stake—holders and real consequences for the society involved. The Alberta program of studies for Chemistry—20 (Alberta Education, 1994) takes this seriously and states the importance of "...the central role of experimental evidence in the accumulation of knowledge and the ways in which proposed theories may be supported modified or refuted" (p.11), and later, "the student should be capable of explaining the role of concentration in risk—benefit analysis and the significance of biological magnification in increasing the concentration of substances within ecosystems in terms of protecting the environment from harm to ensure the quality of life for future generations" (p. 13). The internet provides a place for all stake—holders and interested parties to make their case available to a public audience. The visibility of that material is increased by: a) features of search engines and any awareness an author has of how such tools work, and, b) the extent to which the material draws attention from a public and is informally cited to peers. The importance, value or truth of the material as would traditionally be judged by panels of referees, lecturers and other experts is lessened in the determination of this visibility. This fact may well be a good thing leading to a democratisation of the knowledge building community.

This study provided a real example of this process involving stake—holders from government, industry and education and access to materials written by people with the whole range of possible positions. The discomfort involved in presenting sensitive views from professionals representing particular stake—holdings was evident. The influence of the groups in this study either perceived or actually present was at least coincident with a moderation in the scope of the project. This moderating effect was achieved by arguing for rhetorical structures which suited the stake—holders involved. In the development of a problem for students to solve which is a pivotal point in creating a good experience for learners (Duffy & Savery, 1994) the focus of the study changed from the initial suggestion of: a) a risk—benefit analysis of the production and transportation of chlorine through the city of Calgary to, b) a study in risk—minimisation in chlorine transportation, to the eventual study, c) which essentially demanded an information leaflet for 'What to do in case of chlorine spill' — the kind of information often found in the front of the public telephone directory. Risk minimisation is an objective appropriate to an industrial perspective but misses the remaining rhetorical structure of the cost—benefit analysis by almost assuming that the risk is worth taking whilst at the same time trying to minimise it. The eventual study based on the flyer left little room for discussion of the issues involved placing the authority for making socio—literate comment in the hands of experts. We had expected that students would think it important to make the facts available to the citizens of Calgary and allow them to decide if the risks involved were tolerable (we had no doubt that they were). In this way factors such as but not restricted to: a) the probability of train crashes and leakages, b) the extent of spread of Chlorine gases, and, c) the impact of contact with gas on the human respiratory system, could all be assessed in context and evaluated for acceptability by the public of Calgary. Bringing high—school students to the point of making the links between science and society as required by the Alberta Curriculum is a difficult but essential objective and should not be treated lightly. One of the outcomes of this study was that bringing in stake—holders at an early stage may lead to conflict not just in stake—holder point of view which would add to the interaction but also in the rhetorical structures appropriate to the task.

Data capture

The study was relatively complex involving at least ten people over a period of some five hours. Work spaces were created in different locations, information was available from different sources, conversations went on both in small and larger groups. A problem solving meeting room was established where most of the work and communication was to occur. We made all the usual supports available including white boards, flip charts and over—head projectors. It was hoped that much of the communication would go on in this home room and we could catch all this data. Unfortunately the study suffered sometimes overwhelming difficulties in the collection of data indicating the extreme caution required in setting up such loosely conceived ethnomethodological studies. These problems are regarded as useful results in themselves and will contribute to the generation of a data capture environment at the University of Calgary for studies of this kind in the future.

Implications for Chemistry—20 software

Learning level 20 Chemistry involves the apprehension and integration of complex technical material with connections to difficult socio—economic issues. These issues can help to ground the learner with situations they are already aware of and to help him find a motivation to learn the formal chemistry required. These materials also help locate the impact the real work of science in the community has on human life and the environment. When these objectives are combined with the need for the student to be solving an authentic problem learning

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can be very exiting. The task of this study is to provide guidelines for software development that will allow elegant movement within the material including both the core materials and the socio—scientific issues. The problem is exacerbated by the current trend towards ubiquitous learning where very many people including teachers, politicians, industrialists and pressure groups are keen and able to provide their perspective on socio—scientific issues through the feral medium of the internet. Many of these groups do not agree on conclusions to such issues and often differ in rhetorical standards. Any process of problem solving takes place in the context of multiple forms and in each form at multiple levels of complexity, detail, accuracy, and abstraction (De Jong, Dobson, Sime, Spada, & Van der Marke, in press). The challenge is to make information available so that learners may solve the problem at a level of abstraction enabling a good chance of transfer of both the problem solving skills and the domain material to new and more difficult contexts. Studies in the development of early logic learning (Van der Pal, 1995) show that there must be a balance between the situated nature of the environment and the formal representation. In the science technology and society curriculum the conceptual tools and representations available to the learner are manifold. The formality of the material is high in the chemistry part but low in the social implications part. This range of formality is only one dimension of difficulty in representing the material for exploration by a problem solving learner.

Given the complexity of problem based approaches we propose a simplifying technology in the form of a generic set of schema based on analysis of learner requirements and teaching objectives. Material will be integrated and navigation initially user defined and later automated making use of learner characteristics and progress at the domain. The web based environment brings the opportunity of a flexible formalism in SGML to bring together conventions of rhetorical structures (Toulmin, 1958) with the formalisms of risk benefit to the level of chemical reactions themselves. Once these schema are created the process of course authoring becomes the process of identification of material for particular frames in such a representational scheme. Predictable patterns of representation from the environment remove the overhead to students of learning new structures.

One way to achieve this kind of interactivity would be to code each small stage of a reasoning process into a specially created SGML tag system something like BELVEDERE (Lesgold, 1995). A cgi script acts as an interface to a knowledge base of facts and relations within a domain. The knowledge base is able to answer queries and give explanations for answers to those queries or to provide a sequence of argumentation events presented as a kind of narrative without the user providing a specific query. This is a web based intelligent tutoring system except that instead of using complex authoring environments or developing the tool from first principles the SGML environment provides a ready made schema development environment for creating the knowledge base. A cgi script would be developed acting as the expert tutor and a student model would be developed over time by the system. This is a high—end solution which would require considerable months of development and modelling investment. A solution such as this would compare well with other intelligent internet tools (Brusilovsky, 1995). An engine for course delivery such as this would be complex for the average courseware author although with better authoring its prospects might be improved.

A more realistic recommendation for a system would still likely show gains in learning and at the least an improved speed in problem solving for the problem based learner. This solution would be simple to implement and yet is not known to exist. The goal is to move as much of the facilitation role from the human facilitator to the interface design by maximising the efficiency of conventions used and by constraining the scope of communication to primitives relevant to the user's task. Of all the schema which might be brought to bear here the most reasonable would be based around the rhetorical structures of socio—literate discourse. We therefore choose the rule based informal reasoning schema of Toulmin (1958) as the central device. The primary components of this schema are based — for the purposes of an HTML implementation — on typed links relating to Toulmin's work.

Tags will be created for a first implementation of such a schema and would include: a) claims, b) data, c) warrants, e) rebuttal, and, f) backing. In the original Toulmin structure modality is an operator over claims, backings, rebuttals and warrants - but may not be necessary in a first implementation. These tags will be assembled in the following ways: a) claims - whose truth we seek to establish by argument, b) data - that we appeal to as the grounds for the claim, c) warrants - which provide the rules of inference that connect the data with the claim. These degrees of support will be indicated in the second prototype by the use of: a) a modal qualifier such as necessarily or possibly — there may also be exceptional conditions which prevent the claim from being established and these are indicated by the rebuttal which contains circumstances acknowledged as requiring the authority of the warrant to be put aside. Warrants also require some justification which is the role of the backing tag. The actual implementation of such typed links in web based material would involve the creation of SGML tags to show each of these features. For the user they would be presented with individual identification of material which fits into their own construction of the argument relating to the issue and problem which is being solved. This effectively introduces a cognitive support tool based on the specific use of the web materials for problem solving. The tags will be used in two different ways by a problem solver. Firstly this form of representation helps him to understand material which is already created by others and promotes a critical reading of such argument through the explicit nature of elements in the text. Secondly such a tool allows a problem solver cognitive support in the construction of their own solution to a problem. To summarise recommendations for the development of courseware for supporting problem based learning in both formal and socio—literate parts of the curriculum the following approach would be taken:

1) move implementation to a web based environment based on HTML and SGML;
2) develop a system based around Toulmin's argumentation schemas in three independent stages where tags appear to the user as differently coloured hi—lighting indicating typed links to material which contains: data, claims, warrants, rebuttals and backing;
3) a second implementation would use the modal quantifier added to the claim, backing, rebuttal and warrant tags from which a diagram of the argument structure should be automatically drawn;
4) discussion should be facilitated through the medium of an internet conferencing system where an on—line facilitator should be available;
5) a study would be conducted with different support techniques aiming at reducing human facilitation by providing on—line cognitive support;

Although the description here is based on a web delivery there is no reason why this framework cannot be used to deliver material in stand alone format the only requirement is that at the lowest level of representation the same set of SGML, HTML conventions must be used.

Conclusions

As researchers used to the high personal overhead of focusing on specific research questions and monitoring our successes over time we may forget how easy it is to become distracted by questions equally as interesting as our original goals. This study represents a close to ecologically valid example of eleventh grade chemistry students from the Alberta educational system solving an authentic problem in the socio—scientific area directly in line with the local curriculum. Students were asked to use a range of resources varying in all aspects of mediation, retrieval ease, relevance, and accuracy. This kind of learning environment may be one of the most beneficial of the various forms of constructivist motivated experiences. Certainly the level of engagement in the learning task reflected the predicted high sense of task ownership motivation and goal orientation that the problem based learning delivery style advertises. There is evidence from the dialogues that the goal orientation supported the direction of the learner keeping them on track and therefore avoiding becoming lost in the enormous range of material available to them and therefore providing for a low requirement for tutor guidance. These positive results are moderated by findings that students had significant problems in adhering to the requirements of good problem solving particularly in decision making, pruning of superfluous information, communication between task groups, timing and planning. The study indicates that good facilitation skills appear simple and intuitive but take great effort and practice. Our trainee facilitator built up a good grounding in these skills through the practice of the day but this represented a huge effort on his account. There would seem to be a need as indicated by all of the senior project team in the final debriefing for instruction in problem based learning and or problem solving in general.

The main result of this study from the point of view of evaluation of the materials which were available to the students and the implications for electronic delivery of the Chemistry—20 curriculum will determine the most significant implications for further development. The most effective means of high quality data retrieval for problem solving came from an on—site expert who knew from a certain amount of prior warning exactly where to put his hands on material which could be used by the student. Unfortunately we are not in a position to replicate this kind of retrieval mechanism and so this result represents a future goal. The mechanisms available especially the internet search engines caused extreme difficulty to the students both because of the enormous amount of material on the web (a problem that will only get worse) and because the process of search was alien. The striking contrast in the time spent in accessing material from each source compared with actual source of content in the intermediary product exemplifies this finding. Several recommendations are made for development of the courseware which will serve both the loosely defined nature of representation is science technology and society issues as well as the well-defined nature of formal chemistry itself. These recommendations should build a seamless link between those two parts of the chemistry curriculum helping to motivate the student through the connection with the formal to the environmental and help them to more properly understand the rhetorical structure of informal argument and how it may be supported by experimental evidence and scientific understanding.

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HYPEREXP: A Generic Hypermermedia and Knowledge Based interface to Teach Decision Making.

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The teaching of decision making is an interesting domain for Intelligent Tutorial System, since the systems developed can serve first for training but eventually as task support environments. The HYPEREXP environment was designed to help the visualization and understanding of decision rules in order to teach decision making. It was designed to be a generic environment, where the application and knowledge are completely separate, partly so the later could easily be adjusted. The system uses a graphical representation of sequential dependencies among knowledge elements organized in contexts. It offers passive and active help, presenting contextual and hierarchical explanations on the on going process. The knowledge and the hypermedia structure of explanations are described in external databases, which are easily modified by non-expert and which can be displayed for explanation of decisions.

Context of the research

Knowledge representation and understanding

The problem of knowledge representation and understanding as been investigated not only in the context of learning, but as a first step in the domain of knowledge acquisition and validation. Various formalisms have been proposed to communicate with experts on their strategies of decision. First, rules are modular, easy to understand and have long been used as an efficient way to describe strategies. Though if each rule is easy to understand in isolation, their interactions become very complex, when they are all combined in execution. Clancey (1983, 1985) working on MYCIN pointed out that the rules have to be organized in a hierarchical fashion following general heuristics of decision in order to be easily explained and learned.

If a general level of abstraction is important to apprehend the global heuristic, various formalisms have proved to be more efficient to describe more detailed aspects of the decision. For example, tables are useful to facilitate a more analytic and systematic examination of decision rules especially in complex domains (Yazici, Muthuswamy, & Vila, 1994). Boose, et al.(1988) have used tables to bring experts together in establishing relative weight to relations among concepts.

Finally, simplified graphic representation of dependencies among knowledge elements have proved to be very useful to simplify the understanding of strategies (Holtzman, 1989). These graphics serve as a synthetic representation of the decision, they help the understanding and reminding of contextual information during the process of decision.

These various representations complete each other in bringing both a general and a detailed understanding of the strategy. The present project following our previous research with the ALADIN knowledge acquisition system (Dufresne, Muzard, Legault, & Dufour, 1992), tries to integrate graphics, tables and rules' representations of decision to facilitate the understanding of strategies.

Interfaces to facilitate learning for complex tasks

Research on learning environments to facilitate learning of complex tasks like programming or decision making recommends to leave some initiative to the learner so he can really develop a representation of the problem and also pace the exploration to his understanding. According to Jonassen (1993), it should be a "generative environment where the user has to do more processing, enabling him to think and learn on a higher plane". More passive learning leads to a "reconstruction learning" that does not favor transfer of knowledge, and seems even less adapted for the learning of heuristics.

On the opposite we found that users preferred more control from the system (Dufresne, 1992) they wanted to be guided, when they are learning complex procedures. While learning database operation, learners preferred a linear environment to a more flexible one. In fact graphical cues in the interface and feedback on their progression was found to be sufficient to guide them and insure that they would complete the exploration.

A more flexible hypermedia environment to access knowledge and a more declarative approach to teaching, seems to impose a higher cognitive load that is stressful to the user. The difficulties to explore the interface and to keep track of the navigation interact negatively with the learning process. Kay, & Black (1990) describe steps in the learning of procedures going from examples, to alternatives and more complex plans. These suggest that a certain progression in the description of the strategy is necessary and that the level of control and help should vary as the user progress in his learning.

The problem of teaching complex heuristics has some differences with the teaching of procedures.

We think that both functional and declarative approaches should be reconciled, and offered to the user in a richer adjustable environment. The user should be given the opportunity to have a flexible and guided introduction to the strategy. As a first step he may be introduced to the domain following a structured scenario, and the learning of simple relations. These would then make it easier to later proceed to the learning of more complex heuristic declarations and relations stating alternatives or exceptions.

Also, graphic representation of the association between elements of knowledge can help users build their representation of the problem (Heeren, & Collis, 1992). As Zhang and Christopher (1987, in Yazici, et al., 1994) propose "mental pictures with context instructions improves performance... the possible reason is that the picture display helped subjects to store the relationships between the system variables in working memory, thus functioning as a memory aid.". So following Kay's, & al. (1990) approach we propose to use both a graphical overview of the decision and to give examples to facilitate the building of a functional and analogical model of the domain (Sebrechts, Marsh, & Furstenburg, 1990).

These graphical overviews should be organized according to the contextual structure of plans, as they unfold to test various hypotheses in succession as the decision progress. If plans are an important part of the understanding of novices, more complex schemas are developed by experts as they gain experience. The possibility to explore difficult cases or enter new one should later help the learners to test their plans and to develop experience and efficiency in their understanding.

Hypermedia interface to facilitate learning

Studies on hypermedia design suggest different tools to support the navigation process that can be very useful in the context of learning. Both global and local maps of hypermedia information are important to support orientation and remembering of the structure of information. These maps should be developed to highlight the structure of the information, following various ergonomic principles: semantic grouping, internal and external coherence. If a global overview of the relations of the domain is important, we found that contextual cueing is also important to direct attention in complex environments and to support the learning process (Dufresne, et al. 1990,1991; De La Passardière & Dufresne, 1992). Constraints can be added to navigation maps, to dynamically highlight importance or scheduling of the more relevant elements at a specific moment. Elkerton, & Williges (1989) also suggest to adapt the interface to the user progression, using both active and passive help, giving more feedback to the user. We found that graphical properties of the elements in the interface could serve as non intrusive feedback to guide the progression of the user telling him what he has already done, how he is doing and what he should do next. Historic feedback (footprints, timelines) not only guides the user in his navigation, it encourages him to complete his exploration.

Finally we found that if users prefer to have the information organized for them, they needed diversity in the type of learning material. Access to explanations, examples, exercises and tests on the same material was important to bring them to an active learning process, especially considering differences in initial knowledge, and in cognitive style (some would rather risk a test, other preferred to be guided , some would peek at examples before they start reading definitions.

From knowledge representations to learning systems

Explanation of decisions was the first step to transform knowledge base systems into teaching systems. HOW was a decision taken? or WHY is an hypothesis pursued ? were used to described the rules used for decision making. As Clancey (1983) have shown explanation of specific rules is insufficient to help the user develop his understanding, because rules are too modular, technical and appear without their general context. Heuristic should be explained at a more general level.

Guidon-Watch was developed to integrate explanations in a contextual and time-dependent fashion, but the unfolding of hypothesis and decisions tend to make a very complex and textual interface, which was very difficult to read and follow for the learner. The interface should be more adaptive to the user needs.

Bergeron (1994) experimented a system to diffuse medical knowledge, where users were left to choose the level of explanations they wanted; they used filters to get expanded acronyms, definitions, normal values, level of details, etc. Normal values were the more frequently used type of filter.

As for Hypermedia systems developed to teach decision making in medical science, they may be grossly characterized by two types: cases based and encyclopedic knowledge. In some area a limited number of schemas is sufficient to help the learner grasp the basics of decision making. In other cases, the decisions are based on perceptual discrimination of properties; in those area a well-organized database of examples can be useful to serve as a reference and teaching tool. In most area of decision, both approaches appear to be insufficient to foster a general understanding of the decision process and an eventual transfer to similar or more complex cases.

Finally the integration of hypermedia and simulation environment poses the problem of adapting and actively defining contextual structures of hypermedia explanations, depending on what is the active context and the user needs at one point in the decision process. It also poses the problem of allowing more flexibility and control to the user in a knowledge base environment.

Description of the system

Statement of the problem

The objectives of the research were to develop and investigate an efficient interface to teach decision making. Studies in fact are contradictory, they point at the necessity to control and support the user through scenarios, but also to bring him to be active and reflect on general meta-strategies. In fact the level of control of the system have to vary or adapt itself to suit the user cognitive style, his level of understanding, and his developing expertise. This problem of mixed control poses the problem of coherence and transparency of the interface. How can the interface be transparent enough, so the system can help the user without surprise or interruption? How can it be simple enough, so the user can fetch additional help when needed?

If the balance of control between the user and the learning system should be varied, so does the content of explanations. It should be possible for the user to choose the types and level of explanations, he wishes to have automatically (active help), and which one he could get when needed (passive help). Those explanations should be offered depending on the task and learning context and they should be organized hierarchically so the user can have general information and then be left free to explore in more details.

A visualization of the planning structure and also temporal and schematic cues appear to be important ways to support the user in his understanding of the evolving decision. Since decisions often have a perceptual and qualitative dimension, graphics, images, audio and videos can also be helpful to develop a more analogical understanding of the phenomena.

Simple, easy to update and a front end for research

Before describing the HYPEREXP system, it is important to consider the constraints that were considered in its design. First, in designing the interface, it was important to avoid the double learning problem, which meant that the interface had to be simple enough so the learner could concentrate on understanding the content not on his manipulation of the system. The second constraint was that the system had to be easy to update and to prototype. Since knowledge elicitation is a difficult and never ended task, it was important to define an environment where the knowledge base and the explanations could easily be updated, by domain experts.

Finally the purpose of the system was partly to experiment functionalities and versions of the interface, so it was important to include in the system, functionalities to keep traces of the user manipulation and also his comments on the content and on the system.

Design principles for the interface

Considering the complexity of the content to be learned, it was important that the interface be both controlling and guiding the user progression, while leaving him some flexibility for exploration. The interface had to offer a simplified view but transparent account of what was guiding the decision process.

The design principles for the interface were to offer:

- flexible and contextual access to data-entry, rules and explanations
- hierarchical levels of explanations, both active and passive, starting from information on the meta-strategies and planning and going to detailed account of the rules and objects of knowledge.
- different representations of the elements of the decision process using schemas, graphical animations, tables and rule representations and multimedia illustrations of phenomena for symptoms identification and explanations

A generic system developed using external tools

The system was defined independently of the knowledge and explanations, in environments where it was easy for domain experts to organize and consult them. We used spreadsheets (Excel) to represent the rules and database (FileMaker) for objects and explanations. The HYPEREXP shell was developed in Hypercard that made it easy to prototype the interface, to develop multimedia functionalities and to link to external applications.

Representation of the decision knowledge

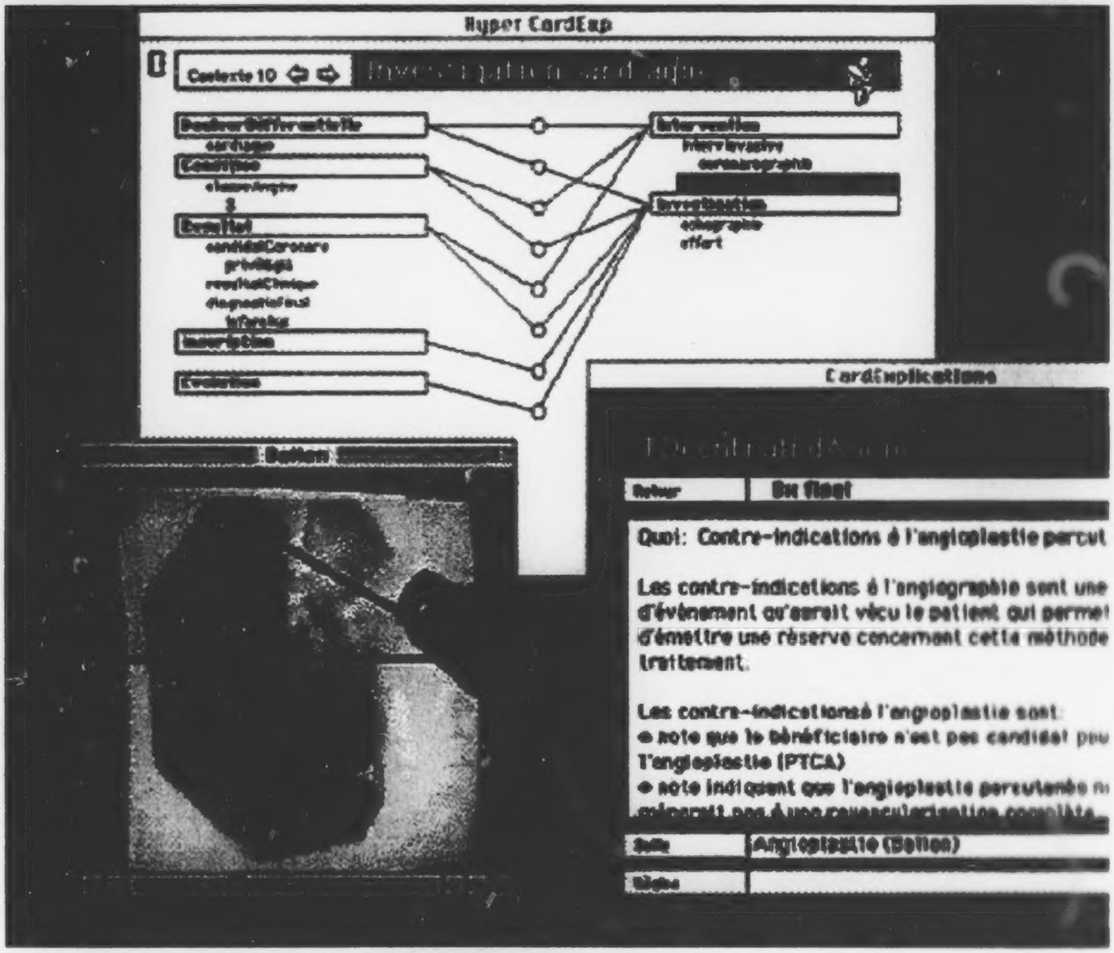
The strategies are presented as a structure of different contexts, where various elements and their relations are presented to the learner. This schematic representation makes it easier for him to understand and remember the global structure of plans (see also Yazici, et al., 1994; and Heeren, et al., 1992, for the importance of schemas).

Finally contextual structures of explanations were described and organized hierarchically from general to specific, answering question like What is this parameter ? Why should I know it ? and How can I decide its value? For each query, a general answer is given, from which the user can pursue on more detailed or related subjects. Active tutorial interventions can be described in the Explanation and Knowledge databases. Systematic explanations are scheduled to appear as decisions are made or as the context changes: Why pursues this hypothesis now? And How should you plan and decide in this context?

Once knowledge is described, it can be imported, compiled and tested in the HYPEREXP inference engine and interface. The graphical interface for the different contexts of decision are inferred from the compiled description of knowledge elements. It is organized hierarchically in classes, properties and values that can be explored and manipulated by the user.

Fig. 1 - Example of interaction with the CARDEXP system explaining a cardiac intervention.

The system



Quoi: Contre-indications à l'angioplastie percut

Les contre-indications à l'angiographie sont une
d'événement qu'aurait vécu le patient qui permet
d'émettre une réserve concernant cette méthode
traitement.

Les contre-indicationsà l'angioplastie sont:
• note que le bénéficiaire n'est pas candidat pou
l'angioplastie (PTCA)
• note indiquant que l'angioplastie percutanée n

Angioplastie (Ballon)

Figure 1 presents an example of interaction with the interface.

The graph present how some parameters influence the decision on a cardiac intervention. It is dynamically modified as the user enter values. He can adjust more than one parameter at a time to see how they interact on the decision. The graph represent the hierarchy of the classes, parameters and values. It is partly elastic, since each class can be stretched to view or closed. (These are similar to local and global maps in hypermedia.) Each parameter can also be opened to change its values. As the user enter the values, he can visualize the effect of these added knowledge and ask question on it. His attention can be guided both graphically or through active hypermedia explanations. The system can be used to explore typical cases or to enter new ones. The user can adjust the level of feedback he receives automatically.

Discussion and Prospective

The HYPEREXP system proposes an environment to support the learning of complex decision making. The system combines aspects of strategic explanations like in GUIDON-Watch, a graphical representation of the decision process that has proved to be helpful to support understanding and remembering of knowledge and the power and

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flexibility of hypermedia explanations.

As a first step we wanted to make the system adjustable by the user himself and to investigate how he choose and evaluate the elements of the system, especially depending on his initial level of expertise of the domain. We will eventually develop adaptive functions in the interface, so the level of feedback and explanation is automatically adjusted to the user navigation and anticipated needs. The explanations actively presented at the beginning of the session or cases chosen for demonstration could be replaced by others as the user demonstrates his understanding.

The system is interesting because it offers a generic structure to develop knowledge base multimedia environments to teach decision making. We are currently using it in two areas of decision making: for the diagnosis and treatment in cardiology (CARDEXP) and for repair and restoration (REX).

Also, since the knowledge and explanations are defined independently, they are easy to update, which accelerate the prototyping and adjustment of the system. This could eventually make possible the sharing of knowledge using the system, the users could add comments, new cases or additional references using specific forms in the system. These could be controlled and added to the knowledge base.

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An Internet-Based File Management System for Microcomputer-Based CBI Courses

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Abstract: There is a great deal of courseware being developed for delivery on the World Wide Web today using standard Web browsers. While Web browsers do many things extremely well, they are not specifically designed to provide direct instruction as are systems such as Authorware Professional ®. Rather than try to force a Web browser to become an instructional system, we have added network capabilities to Authorware Professional to allow it to communicate over the Internet to load and update Authorware Professional modules, keep track of student restart data, student performance data and user license data. One of the side effects of using Authorwaree Professional rather than a web browser is that the source code is well protected since the user accesses object code only.

Introduction

In the past, Computer Based Instruction (CBI) courses generally were delivered using main frame computers. systems such as the IBM 1500 and Control Data Corporation's original PLATO (Programmed Logic for Automated Teaching Operations) were capable of delivering course materials simultaneously to a number of students. These systems were also able to maintain an extensive centralized data base that recorded individual student activities and progress. With the courseware being delivered from a centralized location it was a relatively easy matter for the instructor to make course content corrections or updates. This updated courseware was then immediately available to students. While very successful, these systems were limited because course materials could only be delivered to students who had access to terminals connected to the mainframe.

The advent of the microcomputer has made possible the independent delivery of CBI course materials at any number of locations. Course materials can be delivered to students on floppy disks or CDs, students only need access to a microcomputer capable of running the software. With the need to be connected to a mainframe computer eliminated, microcomputers provided an avenue for instructors to reach a wider audience. CBI courses can be delivered virtually anywhere in the world.

However, this method of delivery has its own drawbacks and limitations. Foremost is the static nature of this form of instruction. Once written and distributed it is an expensive and time consuming endeavor to redistribute course material when corrections and improvements are made. Also, the loss of a centralized database of student information (student answers, latency, study patterns) that could be used by course authors to improve instruction presents a second limitation.

This project uses the Internet and some specialized tools to combine the mobility and ubiquity of the microcomputer with the centralized database and ease of updating course materials previously only available with mainframe delivery. The project had three goals. One was a system that would allow a student to start a CBI course at one university, then move to a different computer or even a different country every day and continue the course at the precise point where it had been discontinued the previous session. The second was to make the newest updated version of the course available whenever a student started regardless of physical location. The third was to maintain a database of student information.

In short, as long as a student can connect to the Internet, that student has access to the latest version of the course and is able to continue were the previous lesson left off, regardless of physical location. As well, any course work done by the student is recorded and stored in a centralized location.

Problem

Project Goals

The intent of this project was to demonstrate an Internet-based file management system for microcomputer-based CBI courses. More specifically, the project was designed for use with courses authored using Authorware Professional ®, hereafter referred to as Authorware, in the Macintosh environment. The project's main focus aimed at developing a method of CBI course delivery and maintenance to remote locations using the Internet as a medium.

The project goals were to allow for the maintenance and updating of student records, regardless of student location; restart a student at the appropriate point in the course, regardless of the computer being used, or the students physical location; automate the updating of revised instructional modules; allow student to easily report errors/problems in course materials; and design and implement a license data-base.

Delimitations

The following delimitations were imposed to enhance project manageability. This project assumes the availability of a continuous Internet connection; the availability of unlimited storage space for user files and programs on the server and personal computer (PC); the initial Authorware course module is located on the individual student machine rather than a LAN server or similar delivery platform; and the Macintosh environment.

Quick Overview

Server

Hardware

This project was developed using an IBM RS/6000 *Server* using IBM's AIX (Advanced Interactive Executive) 3.2 operating system. It has since been ported to a Sun SPARC Station Server using the Solaris 2.5 operating system. The decision to use a UNIX based operating system was partly based on the need to develop the communication tools required to transfer information between the server and client user, tools best served by the UNIX environment.

The server operates as a stateless server (Dewire, 1993). That is to say, the server does not maintain information about the status of ongoing or previous interactions with clients. The server receives a message or request from the client, processes it, sends a return message and exits from the interaction. Each request is dealt with independently with only a single request being accepted from a given client at one time. The obvious advantage of using a stateless server is the reduced resources required for each client connection. The stateless server ideally suited project purposes where the information being transmitted at any given time can be viewed as an independent packet requiring a single response.

Another advantage of using a stateless server is that either the client or server can crash (unexpectedly fail or shut down) without causing difficulties for the other. In the event that the server crashes the client has only to repeat the request until the server responds. If the client crashes there is no degradation in the server's operation. More specifically, in the event of a server crash the student is able to continue with the lesson as if nothing has happened and seek a server response once the server is again operational.

To track student activity we have installed a system log file that records all server activity. This file is updated with each information request and includes the date and time, user ID and, the nature of the request

Command Language

The server commands are written in Perl (Practical Extraction and Report Language; Wall, Christinansen & Schwartz, 1992, 1996). This is a scripted language used for the manipulation of text, files, and processes and was chosen for its relative simplicity and platform independence. Our main concern was that client/server communication be as efficient and rapid as possible. This is an important concern if we want to provide client/server interaction that is as seamless as possible for the student.

The server commands are written using an "elsif" structure where the appropriate loop is initiated with the given command as the key. Owing to the stateless nature of the server, and the elsif structure, a given command string can only initiate a single process. Thus, repetitive commands require that the user repeat the request.

Commands are sent by the client using TCP/IP (Transmission Control Protocol / Internet Protocol). These commands are sent as a character string containing the server address, user ID, user password, and the command string.

At the conclusion of each command sequence, a character string is returned to the client indicating success or failure of the command. Successes are indicated with a simple returned text string "Succeeded." Failures are indicated with an explanation of why the given command failed. Depending on the nature of the failure, the user can make the necessary corrections and try again.

Client

As noted earlier, for the purpose of this project, client is any Macintosh computer capable of maintaining an Internet connection and running the Authorware courseware. Work on the project proceeded on the assumption that client was delimited to a continuous Internet connection to facilitate the transfer of information as seamlessly and unobtrusively as possible. Other than at the initial login the student should be unaware of any client/server communications.

The TCP/IP protocols available on the Internet make it possible to create an ubiquitous environment for our client users. In other words, the only limitation to client location is the availability of an Internet connection.

Communication Protocols

The communication link between client and server is maintained via the Internet. While the client requires a continuous connection to the Internet the connection to the server itself is only made when the client requests or sends information. The two protocols needed to access the system are TCP/IP and FTP. A third protocol, Telnet, is used by the system manager to administer and operate the server. These three protocols are part of what is known as the "Internet protocol suite" (Hedrick, 1987).

This project required use of some specialized tools that allow application of the above protocols. Specifically, AWQuery and AWFTP XCMDs (pronounced x-commands), were written for this project by an external consultant.

AWQuery

AWQuery establishes a TCP/IP connection with the server. Commands are sent from the client to the server in the form of a character string via this connection. The server parses the string, interprets and carries out the command, and sends a reply.

AWFTP

AWFTP is used to move larger files and programs using the Internet protocol FTP (File Transfer Protocol). This routine allows the provision of remote updating of revised modules as well as storage of student progress data.

TELNET

This is the third protocol used to access the system. There are no special routines or commands written for or used by this protocol. This is to be used solely by the *Manager* to work directly with the system files and functions not accessible through the user interface.

Client/Server Communication

The project design requires that all client/server communication be initiated by the client. The parent server computer was configured to allow communication to our independent server process through a designated socket or communication port. In other words, direct and continuous communication is available to the work space designated to this specific project.

When a command is sent to the main server computer, it is routed through the designated socket and received by the project server process. A child process is spawned leaving the parent waiting to respond to a request from another user. The child process carries out the command, sends a response, then shuts down. This enables the server to respond to a number of users simultaneously.

To allow different servers to be used for different courses and/or physical locations, part of each communication string sent from client to server contains the physical Internet address of the server.

File and Records Management

Four user groups are identified: student, lecturer, license holder and system manager. Each user group has different needs and requires separate access and interactive capabilities. The needs discussed below cover the basic requirements for each user level and are hierarchical in nature. That is, each higher level is granted the privileges of the preceding one.

Student

A student is any user accessing the system as a course learner. Few privileges are needed at this level other than the ability to access course materials, performance and personal records, and to check the license data-base. To accomplish these ends the user must be provided with a means to connect and log onto the system; access to updated modules; store and retrieve progress data; store and retrieve personal files; and send messages to course developers. In addition, the project design allows the transfer of files in a manner such that the user is unaware that client/server communications are occurring.

Login

The project design provides a means of allowing the student to successfully connect and log on to the system via a small Authorware program, which utilizes the AWQUERY XCMD, and allows each individual student to send and confirm his/her ID and password to access server resources. For security reasons, the command strings necessary to complete this task are hard coded into the software.

The only time an individual student must interact with the server is during login when the student is required to enter an ID and password. This information is then used in client/server interactions to access student specific files and records. Access to server resources is contingent upon the correct entry of a legitimate ID and password that is associated with a valid user license.

If the student does not enter a valid ID and password, or the user license the student is associated with has expired, a message is displayed that access to the server is denied along with a reason why. The student is, however, given the option of continuing with the course modules which exist on the client computer.

Once the student's ID and password have been verified, a request is sent to the server to determine if a record of the student's e-mail address exists in the server's records. If not, the student is asked to enter his/her e-mail address, if available. If the student does not enter an e-mail address, this request will appear on each subsequent login. E-mail addresses are used as a means of responding to student questions.

Module Selection

The majority of the work required to access updated modules and the retrieval and storage of program data is carried out by another Authorware program called the "router". Student restart data and new modules are transferred by the router using the AWFTP XCMD. The student interface was created by Jamie Higham

(University of Alberta Authorware Programmer) as part of a course called *Understanding Statistics*.

When the student selects a module the request is sent to the server to determine if this is the first time the student has started the module. If the student has previously started the module, the restart data is downloaded to a user folder. Before the student is allowed to continue, a check is done to confirm that the module exists on the student computer. If the module does not exist on the student computer it is downloaded. If the student is continuing with a previously started module the student begins at a "restart" point which is the exact location in the course where the student previously exited that module. It is possible for a student to have started a number of modules. A restart location for each module is stored as a separate file and only accessed when the student chooses to continue the given module.

If a module has not been started, a request is sent to the server asking for the version number of the most current module. This information is then used by the client to determine if this module is available on the hard drive. If the module exists, no further action is taken and the student continues with the lesson. If, however, the module available on the client hard drive is outdated, the updated version is downloaded via FTP to the courseware folder. Figure 2 is a simplified representation of the client/server interaction during a student session.

Student/Client/Server Communication

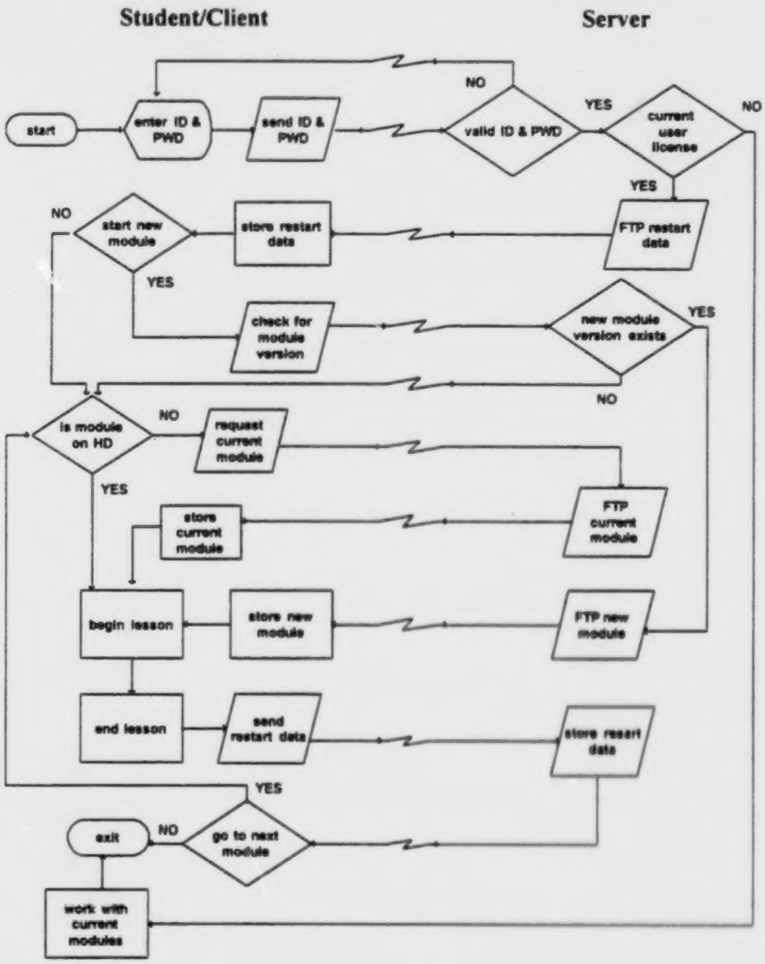
Student/Client
Server
start
enter ID & PWD
send ID & PWD
valid ID & PWD
NO
YES
current user license
NO
YES
FTP restart data
store restart data
start new module
NO
YES
check for module version
new module version exists
YES
NO
is module on HD
NO
request current module
YES
FTP current module
store current module
begin lesson
store new module
FTP new module
end lesson
send restart data
store resart data
YES
exit
NO
go to next module
work with current modules

Figure-2: Client/Server Interaction

Message to Authors

Our experience and that of others (Alessi & Trollip, 1991; Hunka et al., 1978) is that some of the most valuable feedback about the quality of a CBI course and ways to improve delivery comes from the student. To take advantage of learner feedback the project design includes an option whereby the student is able to send a message to the program authors from within the course.

At any place in the course, the student can select an option to send a message to the course authors. This is then passed to the server as a text file containing the student ID, email address and pointers to the specific location within the program from which the student is sending the message. This allows the authors to quickly pinpoint the problematic course information and make changes that may be warranted. The inclusion of the student ID, and email address gives the author the ability to direct a message back to the student if additional information is required, or to simply acknowledge the feedback or provide clarification to the student if the feedback is based on the individuals misunderstanding of the course content.

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Server Failure

Because client/server communication cannot be guaranteed each time a student attempts to log onto the system, or if server failure occurs during a session, the student must be given alternatives to the various scenarios that may occur. A server failure for the student who is starting a course for the first time is not as crucial as it is for a student who has already begun the course. This is because the first time student has no restart data that must be retrieved in order to begin the course.

If the server is not available at logon, a message is displayed informing the student that any restart data will not be available for this particular session. If the server is not available when the student exits a module a similar message is displayed informing the student that the restart data from the current session cannot be sent. The student is then given the opportunity to save this data on a local disk to be used the next time they start that particular module. If the server is running the next time they log onto the system that data is then uploaded to the server.

Lecturer & License Holder

A lecturer would be any individual acting as a course instructor or facilitator. This individual is registered by the license holder and would be the one with the most direct contact with students. Thus, this user level requires the authority/ability to register students, remove students, and change student passwords.

The interface for the student and lecturer are packaged together using the same login screens. If the user logs in as a lecturer an option is provided allowing the user to indicate whether they are accessing the system as a lecturer or student. This provides a lecturer the ability to access student records while in the lab working with the students. It also allows the lecturer the ability to access course materials.

The license holder is the individual or institution that has purchased a license permitting access to server resources. The primary concern of this individual is assumed to be the assigning of course lecturers. However, this individual may also need to register and work with student records. Thus, the privileges and interface are the same as for lecturers with the additional ability to register lecturers. lecturers are not permitted to register other lecturers.

System Manager

The System manager is the individual responsible for the overall operation and maintenance of the system. The primary responsibility of this individual is the administration of the course(s) offered. The system manager is responsible for registering new license holders and ensuring that the most current modules are uploaded to the server. However, this individual is also responsible for ensuring the system runs smoothly by correcting any problems as they arise. This individual should have access to all areas of the server and have the ability to change and/or modify all files and databases therein regardless of ownership. The system manager must be aware of the ethical responsibility concerning modification of private files; however, in the event that these files are causing system failures and/or disruption to the overall performance of the system there must be some recourse available.

The registration of a new license holder initiates two important processes on the server. The first is the creation of a license specific directory. All users associated with this license are given storage space here for personal records when they are registered.

The second is the entry into a central database of the license expiry date. All client requests received by the server initiate a call to this database to confirm that the user making the request is associated with a viable license. If the license has expired a denial is returned to the client informing the user that further information requests will not be accepted until the license has been updated. With this information stored in a single location it is a relatively simple operation to update the license enabling all associated users to once again access the server.

To update course modules the system manager need only indicate the course being updated and the nature of the upload; new module or update. When a new module is uploaded an entry is automatically made into the course database indicating the correct version number and the module is then uploaded. When an update is initiated the database record for that module is read and the version numbers automatically updated to reflect the status of the new module. The new module is then uploaded with the proper version number. The previous module remains in place in the event that it will be needed by a students who have already started that particular version.

Shockwave Comparison Time Trials

As stated earlier, this project utilizes Authorware Professional from Macromedia as the authoring language for the courseware and the user interface. In an attempt to utilize the ubiquitous nature of the Internet, Macromedia have themselves developed a delivery system known as Shockwave®. This method permits developers to deliver their courseware, animations, digital video etc. using a WWW browser such as Netscape and Microsoft's Internet Explorer. Macromedia supplies the software needed to transform a project into a format that can be accessed via the WWW. Although this project and the Shockwave system utilize the same communication medium, preliminary testing has shown there is a considerable time difference in their delivery.

A series of tests were run using a Power Macintosh 8500/120 using a 28.8 baud modem. A portion of the *Understanding Statistics* course was shocked and uploaded to a WWW server. At the same time a program *kernel* containing all the files a new user would need to start the course was compressed into a self extracting file and uploaded to the same server. The timings were logged on the appearance of key elements on the computer screen: the initial login screen, program menu, course module, return to menu and finally the logout screen.

Our tests showed dramatic differences in access times for the various project components. We have also conducted other timings using cable modems and direct Ethernet connections. For the purpose of this paper the modem timings are used as this is the most likely connection used by the public at large. The following table shows the access times using a 28.8 modem.

Shockwave

Login	Menu	Module	Menu	Logout
2.00	**14.50**	**21.20**	**26.14**	**33.35**
0.33	7.00	11.00	15.30	16.20
1.35	7.32	12.10	16.50	18.35
0.33	5.02	9.30	13.40	14.40
2.00	**15.13**	**19.40**	**24.10**	**25.45**
0.34	4.54	9.00	13.30	14.13
1.31	6.45	11.30	15.40	22.40
0.33	4.48	9.45	13.49	14.37

Project

Login	Menu	Module	Menu	Logout
0.10	**15.50**	**18.42**	**19.06**	**19.29**
0.04	0.39	0.54	1.12	1.27
0.04	0.40	0.50	1.06	1.23
0.05	0.38	3.45	3.59	4.16
0.06	**15.50**	**18.41**	**19.00**	**19.18**
0.04	0.34	0.45	1.00	1.15
0.09	0.37	0.47	1.00	1.19
0.09	0.35	3.55	4.00	4.29

These times are cumulative and include entering a student ID and password. The bolded numbers indicate the first run of a test when there are no user files or cache available. The access speeds for both systems dropped dramatically with more files available on the hard drive.

The real advantage of our delivery system, is once the files reside on the host computer very little client/server communication is needed. This is then limited to the transfer of small (32K) packets of restart data. There will be times when a new module or library file is downloaded, but this will only have to be done one time. This is in contrast to the constant client/server communication needed to access the same files with a WWW browser. In all fairness to Macromedia our particular project requires the accessibility of a number of components at any given time. We found the Shockwave worked very well once we had them loaded. However, the latency is unacceptable for a project such as the *Understanding Statistics* course

These test are very preliminary and indicate that more rigorous testing using a variety of connections and hardware are needed. Plans for such testing are currently underway.

Summary

The exponential growth of the World Wide Web and the Internet has brought with it a subsequent flurry of activity as educators try to take advantage of the potential for world wide communications. The relative ease of communicating over great distances makes this a very attractive medium for course delivery. A variety of methods have been employed that include the use of forms in browser based delivery, the use of browser plugins permitting the client to view small applications, text based instruction in HTML format, and computer conferencing. While each of these methods are useful and can be employed to meet specific needs, they fall far short of the potential for CBI. The success of this project allows the designers of CBI to take full advantage of the communication medium offered by the Internet while retaining the strengths inherent to this form of instruction.

Perhaps the single most important outcome of this project is a product that provides for the immediate availability of updated course material without the logistical and administrative headache of sending new CD's or floppy disks to all students taking a given course. Developers of CBI are well aware of the ongoing nature of course improvements and adjustments, many of which cannot be made available to the student presently given the logistical considerations. The project's product ensures that student's registered in CBI courses will always have available the most current updated version of a course.

The storage of student performance records and direct feedback to the course authors provide valuable information to both the student and instructor that ensures course improvements can be made quickly, based upon "real" and current student data. This valuable information had been lost to course developers using CD technology. However, this project provides information analogous to that available on PLATO and it's centralized database system.

The system log file that keeps a record of all server interactions makes it possible to track student activity. Use of this capability may offer researcher a wealth of information about the frequency and duration of student learning interactions and the learning achieved. It would also provide information on areas of the course causing students particular difficulties based on the time it took students to finish a particular module or concept.

Course administration is relatively easy and can be done from any location with an Internet connection. Student rosters are easy to maintain and the indexing system provides all users with individual storage space for course related files. Built in security ensures that these files remain confidential and non-transferable to unauthorized users.

Finally, the license data-base allows the vendors of software a very simple way to control access to updates, while having the opportunity to allow their licensed users to update their license immediately without the need to use international mail systems to transfer electronic media and funds.

Unlike most other forms of Internet-based course delivery, the student is able to work on course materials without an active connection. The absence of an Internet connection only prevents automated module updates and record keeping capabilities. However, with the student able to save restart data on a local disk, this information is available the next time the course is accessed. If an Internet connection is then established, new records may be uploaded to the server for permanent storage and later retrieved

The microcomputer provided developers of CBI the ability to deliver course material to a much wider audience. Our system provides educators the ability to easily administer distance education courses on a world wide level. At the same time this ubiquity is shared by students who can access course materials and personal records regardless of location. The only limitation being the presence of a program kernel and an Internet connection.

Granted, some new problems are also generated. In its current status, the full benefit of this form of delivery is only available to individuals with a continuous Internet connection. This could provide serious financial considerations for the home user that must pay an Internet Provider an hourly rate for their service. A future enhancement will initiate a dial up SLIP or PPP connection only at the onset and conclusion of a given session.

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The Case for Database Support in Multi/Hypermedia Application Development and Use

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Abstract: As multi/hypermedia applications increase in both complexity and capability, the demands on both the author and authoring tool increase. The case is made that utilizing a database at the core of both the authoring and execution of theses applications eases these tasks in ways which naturally lead to increased flexibility in both authoring and distribution. The database can be very effective in both the production and maintenance of these applications. By connecting to a central database, remote applications can easily update and modify themselves as well as leave information in the central database. These capabilities are especially useful for both local and distance education applications. Two examples of educational applications that use this database-centric model are discussed.

Introduction

Recent advances in computer hardware and software have resulted in increasingly complex educational and entertainment applications which increasingly incorporate large amounts of multimedia data. The usefulness and appeal of these applications is enhanced by using rich sets of links creating order out of these media objects. In the near future, these applications will maintain their relevancy by becoming dynamic, rather than static. This process will require that applications be able to modify themselves.

Typically, such multi/hypermedia applications are developed using authoring tools which use a proprietary scripting language to incorporate media objects and scripts into the application. This manner of storing media objects has two distinct disadvantages: 1) making changes in media objects often requires the authoring tool, and 2) keeping track of large numbers of external media objects (i.e. .jpg, .avi, .mov files) becomes very cumbersome. Finding the name of a specific media file can involve searching many scripts; moving or changing a file name will likely result in a broken application. Additionally, allowing the user to modify the application is often not an option, as the authoring environment is not available to the user.

One obvious but almost entirely untried answer to these difficulties is to provide database support in both the authoring tool and the application. Databases provide many services which authors will find extremely valuable: a mechanism for managing media objects during authoring and providing objects during execution, easy modification of application content, easy re-purposing of existing media and databases, and separation of content and scripts from run-time engines.

The user also benefits from database-centric design. For instance the ability for local CD based applications to access remote databases via modem or the Internet allows for database-centric applications to form an infrastructure that will greatly benefit educational applications. Just as important, the ability to access remote databases provides a natural means for allowing static applications to update themselves, thus becoming dynamic [Reisman 1995]. The database provides the flexibility needed to implement this hybrid CD-Internet application model.

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The flexibility that database-centric application development and deployment gives application authors is distinct from the advantages that the same database offers the author in the pursuit of the goals of the application. In the first case, the database is used for management and maintenance of the application content, while the latter case uses the database in support of the application itself.

In this and a companion paper [Curtis and Lerman 1997] we make the case that databases serve a crucial role in the authoring and distribution of multi/hypermedia applications. The companion paper describes a virtual database which provides a common interface to many different types of databases: relational, object, object-relational, etc. This is extremely important for integrating both legacy and media object databases into an application. The current paper discusses how they serve to aid in the creation and maintenance of these applications, and secondly, the capabilities they bring to the application help achieve goals important to many educational multi/hypermedia applications. We will outline these advantages, and then discuss our experiences with two applications which were authored and deployed using a database-centric approach.

Database-centric Application Authoring

There are two reasons to author using a database: for managing the media objects and scripts of the application during authoring and execution, and for the benefits that a database brings to achieving the goals of the application. As the number of files that are associated with a single application grows into the hundreds and thousands, keeping track of the type and content of all the files becomes exceedingly difficult. Databases excel at this task, as each file can be indexed by the media type, a description of what it is, what it was meant for, any information that the author feels would be helpful for keeping track of the media. By associating information with the file name, the author greatly eases access to a given media object, since the author then queries the database for the appropriate object, rather than looking through many scripts to find the hard-coded file name.

In a non-database-centric design once the application is complete, the database is used to replace all script references to the objects with the objects themselves. While this seems a reasonable thing to do, there are many advantages to allowing the database to provide objects to the application as it runs. It is much easier to make changes to the media in this model because the content of a database is much more accessible than the content of a multimedia authoring language. Therefore, a user can modify a database-centric application far more easily than one created with Director or HyperCard. Additionally, this "late binding" of content allows for changes to the application at run time: if the text in an application is to be Spanish rather than English, a simple change in the database query will effect this change.

One feature that educational applications need that may differ from other types of multi/hypermedia applications is the ability for an application to track a student's progress through and interaction with that application, and modify its behavior based on that information. A database-centric application provides this capability automatically through assigning each user a separate record that keeps track of such information. The scripts that determines the behavior of the application need only query the database to determine what action to take next.

If one can conceive of an application that depends on a database to serve it media objects, it is a short step to imagining storing the scripts that determine the behavior of the application. If both the content and the scripts of an application reside in the database, then the only role for the application engine is to load and execute scripts. The separation of the execution engine from the application means that any engine that can interpret the scripts and load objects from a database will run the application. This provides independence from any given authoring system: if the Java of tomorrow offers compelling advantages over the Director of today, the task of re-implementing the application is much easier than if the media were hard-coded into Director Lingo, for example.

Database-centric Application Deployment and Maintenance

Most multi/hypermedia applications today are distributed on CD-ROM, due to the size of the media objects, particularly digital video. While a database-centric application would not be any smaller (and would likely be bigger) than a traditionally-authored application, there is one feature of a database-centric application that is compelling: the natural manner in which database-centric applications can modify themselves. To the database-centric application, there is no difference between sending a query to a local database from sending the same query to a remote database, other than the returned data might take longer to arrive. This being the case, updating any number of remote applications that have connections to a central database is equivalent to updating the central database. From this follows the hybrid model of application delivery. For example a distance education application distributed by MIT consists of a database, scripts and an engine on a CD. The teacher may place additional materials on a central database located at MIT. This database can then be remotely accessed via modem or the Internet by the local application. The central database can be queried for updates, which are then stored in a database on the local disk. This model allows what would have been a static CD-based application into a dynamic application that exists in three different databases, one of which is remote.

For educational applications the ability to access remote databases allows tracking of a student's progress as they use the application. The instructor of the course can easily review each student's activities by looking at the appropriate files on the central database. Additionally, this mechanism allows for students to collaborate, as multimedia notebooks can be stored on the central database, while being shared and modified by a group of students. The local application can also be designed to retain information on how the application is used. This information could then be placed in the central database, where it could be used both as feedback to the authors as well as to tailor updates delivered to individual users.

A Database Model for Application Authoring Environments

Today, there are many different types of databases in existence. The most common commercially available database is the relational database, but object-oriented and object-relational databases continue to increase in both availability and popularity.

The drawback to relational databases is that they do not handle complex data types, and therefore media elements are stored as either file systems references or binary data. Object databases allow for much more elegant handling of multimedia or other complex data types. Every database system provides its own proprietary method for interfacing with an application.

Obviously a user will choose a database for a particular application based on attributes such as functionality, availability and price. However, the application author does not want to have to learn how to construct a new interface for every database system that needs to be connected to a new interface. Multi/hypermedia application environment therefore strongly call for a database access solution that allows integrated access to a variety of database system types. Certain application may also find it desirable to connect to multiple databases simultaneously, and so a multi-database solution is required. Unfortunately, no one standard currently exists that covers the wide variety of database systems that it is anticipated will be needed in the authoring environment. The ODBC standard centers on relational database systems, while the ODBMG standard focuses exclusively on object database systems. Application authors may well want to use both types of system. In addition, the functional requirements of a multidatabase interface for application authors have not been adequately addressed.

A virtual database system is one solution to the problem of shared access to differing database types, and it is expected to become a key component in distributed global technology systems in the future. A virtual database provides for a common object data model with which the author interfaces, while transparently taking care of data and schema translation issues that arise between the virtual database and individual component database systems. Since individual database display differing levels of functionality, the virtual database system must provide a flexible interface that allows access to the extended functionality of some databases while providing extra functionality to compensate for the more primitive database systems.

An example of a virtual database module for a multimedia authoring system [Curtis 1996] has been developed at the MIT Center for Educational Computing Initiatives (CECI).

Examples

Two applications have been developed using a database-centric model and the virtual database just described. These applications were authored using MIT's AthenaMuse2 object-oriented multimedia development environment [Harward and Lerman 1994]. In presenting each application, we will discuss the database features used, and relate the difficulties encountered in implementing the database aspects of the applications.

Operación Futuro

CECI is collaborating with Ana Beatriz Chiquito from the University of Bergen to produce Operación Futuro, a multimedia application designed to assist in the teaching of intermediate Spanish to college level students.

The application is divided into three integrated modules. Historia Interactive presents lessons in the form of a non-linear interactive story told over seven consecutive days. The story has several outcomes depending on the student's participatory input. Integrated into the interactive story is also a student work area where traditional exercises and multimedia projects are assigned and completed. The Libro module is an electronic book that is structured into units and includes hyper-linked materials. Text book activities, exercises and assignments draw from the content of the interactive story. The Topicos module is a searchable encyclopedia of information related to Hispanic culture, geography, customs, literature etc. Information from Topicos is also integrated into the electronic book and is available throughout the interactive story.

The integrated nature of the application is possible only because of its database centric design. Each module uses a single database for retrieval of all media and content. This includes the HTML text files for the textbook and encyclopedia, the videos and subtitles used in the interactive story, the thousands of images used in the student work area and even the graphics used to create the application interface. In addition to media, the database will also eventually include the script code for each scene in the interactive story. Since the media used in the interactive story is reused in both the electronic book and in the encyclopedia the three modules can actually be described as three different interfaces to the same database.

The advantages of a database centric design are that it offers an unprecedented level of flexibility to both the teacher and student using the application. For instance in Operación Futuro, teachers can select from existing, or add new materials to the database to create their own customized electronic text book and interactive story. The database will also store information related to the student such as the status of their progress through the interactive story. Assignments given in the student work area can be electronically "handed in" to the teacher. By maintaining a record for each student, Operación Futuro allows for tracking the progress of and grading of individual students.

A database-centric design also allows for remote access of materials. For instance a student living in Montana could take a distance education class in intermediate Spanish by having a local CD containing the database-centric application access the central database at MIT thousands of miles away. The ability for the local and remote databases to easily exchange data enables such applications to easily serve as distance education applications.

While the media that forms Operación Futuro is organized in a manner to effectively instruct users in the Spanish language, the individual media objects could be used for many other purposes by imposing a different organization on the objects. Since each media object has many associated keywords in the database, this reorganization is easily effected. The flexibility of databases is such that this reorganization could be done on the fly.

Operación Futuro was developed with CECI's own authoring tool AthenaMuse2 and is running on a Windows platform.

Long Bow China Archive

The MIT history department, the Center for Educational Computing Initiatives (CECI) at MIT and The Long Bow Group, a non-profit film making organization, are currently collaborating on the China Archive Project, an on-line computer archive of video, image, sound, and textual materials on twentieth-century. The key element to this archive is a legacy relational database, which allows for both users to access media concerning topics of interest, as well as the integration of different media objects into multimedia essays. The preparation of the legacy database for this application posed some interesting problems which will be of interest to authors of similar applications.

The core of the archive consists of over 300 hours of valuable documentary and broadcast film footage collected by the Long Bow Group. The archive material vividly portrays major political events, changes in the rural and urban landscape and the experiences of ordinary Chinese people. In addition the Long Bow archive contains several hundred hours of audio, as well as hundreds of image and text sources. For the study of modern China there simply is no equivalent to this collection.

Recently CECI completed a prototype of the archive that demonstrates its basic functionality and potential. The prototype is divided into two modules. The archive module provides an easy user interface which allows the user to search the legacy database using topics and associated keywords; corresponding media records can then be viewed, read, or listened to and are accompanied by extensive descriptive and source information from the database. The tour module provides a sample of "tours" or multimedia essays that illustrate how the archive materials can be used to construct lectures and/or multimedia essays. In the final project tools will be developed for constructing one's own multimedia essay. Without the database component of this application access to the media in the archive would remain limited, sophisticated searches would not be possible and the flexibility needed for a tour builder would not be present; indeed, the ability to access media from the database is raison d'être of this application.

Work on the China Archive Project began with investigating how Long Bow's existing FileMaker Pro database could be used as the core of the design. In the end, several transformations were required to adapt the FileMaker Pro database for this project. The categories that the Long Bow Group used for cataloging their media (people, places, actions, keywords etc.) had to be compressed into a general keyword list and then associated to one or more general topic categories. This made searches of the archive more efficient. It involved a domain expert deciding on the appropriate categories, and then the programmers performing the necessary merges and links. This issue will likely be ubiquitous when legacy databases are re-purposed for use in multimedia/hypermedia applications. In the case of the China Archive, the original purpose of the database was quite close to what was needed. If this had not been the case, the translation would have been much more difficult.

Other difficulties arose through the necessity of converting the FileMaker Pro database into FoxPro, as FileMaker Pro runs only on the Macintosh platform, while the archive is being developed for the Windows platform. Initially there were difficulties due to the 256-character limits for both FoxPro and our authoring language. Alterations to AthenaMuse2, CECI's authoring language had to be made and a more sophisticated

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database export utility had to be used which converted FileMaker Pro's text files into FoxPro memos, which have no character limit. Another problem that arose during the conversion process was related to the number of keywords associated with each record. In most cases each record had multiple associated keywords, however in the FoxPro version of the database only the first keyword line was recognized. The solution was to merge each record's keywords into one line.

For the demo, the database contained only the descriptions of the media objects; the guided tours were written in a manner that did not use the database capabilities. For the actual application, the guided tours will be included in the database. The application will allow the easy authoring and addition of additional tours to the database by researchers for their own purposes. These tours could be made available to others if the application is deployed as a web site, or as a hybrid application as described above.

Summary

A case has been made for making databases an integral part of multi/hypermedia authoring tools and applications. The benefits range from providing an easy, robust manner for managing an application's media objects during authoring to the ability to easily update or modify existing applications, either by the user or as a result of connecting to a remote database. This allows for the automatic updating of static applications, resulting in a dynamic application that provides capabilities that are important for distance education applications.

We feel that the flexibility that databases offer an application designer, along with the development of virtual database interfaces, will result in the rapid adoption of database authoring techniques by the educational multi\hypermedia community.

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A Distance Learning System for Higher Education Based on Telecommunications and Multimedia - A Compound Organisational, Pedagogical, and Technical Approach

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Abstract: This paper addresses the Semi-virtual Multidimensional Distance Learning System (SMDL), which is a technical, pedagogical, and organisational prototype-structure of a semi-virtual university. SDML includes both synchronous and asynchronous learning modes. During the initial stage of our project, we regularly transmitted a lecture from a specially equipped lecture room in one university to an equally equipped lecture room in another university using ATM technology. The project is evaluated with consideration to technical and pedagogical issues. A variety of technical problems could be addressed during the regular transmission of the lecture for the course of a semester. Empirical data suggested that the remote students were appreciating the new technologies, whereas the local students seemed to be somewhat sceptical. Moreover, the organisational problems in setting up a semi-virtual university seem to be vastly underestimated in comparison to the technical issues.

1 Introduction

In Germany distance learning in higher education is not as widely available as in other European countries. Fundamental problems arise for regular higher education due to the accelerating trend towards differentiation, specialisation in many knowledge domains and also because of the growing demand for qualifications. Hitherto existing television- or video-based distance learning facilities have not allowed for highly interactive instruction. With organisational, pedagogical, and technical efforts being combined, advances in telecommunications and multimedia now allow for a comprehensive Semi-virtual Multidimensional Distance Learning System (SMDL).

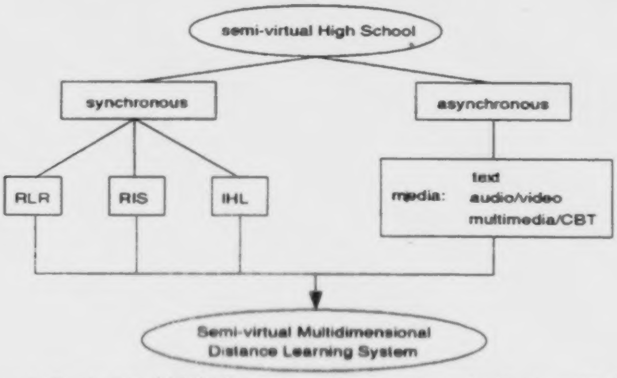

Figure 1: Semi-virtual Multidimensional Distance Learning System (SMDL).

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SMDL includes synchronous and asynchronous teaching and learning modes as well as multimedia technology [Fig. 1]. In the joint research-project „TeleTeaching" [Effelsberg 95] by the Universities of Mannheim and Heidelberg in Germany, we are currently developing a prototype system of a semi-virtual university.

2 Background and Goals

With both universities situated an hours drive from each other, students have always had to commute in order to gain a sound education in their fields of studies. The Universities of Mannheim and Heidelberg have now formally agreed to enhance co-operation in both research and education. This has provided the organisational basis for a semi-virtual university in which courses will consist of both local and remote (by means through telecommunications) lectures, seminars, workshops, and student cooperative workgroups. Students in the newly founded course of studies „Technical Computer Science", by need of taking courses at both universities, will be the first to take profit in this new educational setting. First trials have been made by providing lectures in computer science and theoretical physics for both Mannheim and Heidelberg students. Moreover, we are using multimedia technology to improve both local and remote teaching and learning. The departments of Computer Science at the University of Mannheim and Computational Physics at the University of Heidelberg conduct the hands-on-business of designing and providing technical resources. A pedagogical and psychological evaluation conducted by the department of Educational Science at the University of Mannheim will gain empirical evidence about the feasibillity and effectiveness of the approach. This will in turn form the rationale behind the ongoing advice regarding the design and use of instructional settings and technical properties.

3 Distance Learning Modules

Figure 1 and 2 indicate three different modes of teaching and learning. We can distinguish between main modules and support modules. The main modules describe the types of instruction to be realised. The support modules are thought to account for an efficient use of the main modules. The main modules are characterized by their scope of distribution, interactivity and individualisation of the learning process [Fig. 2].

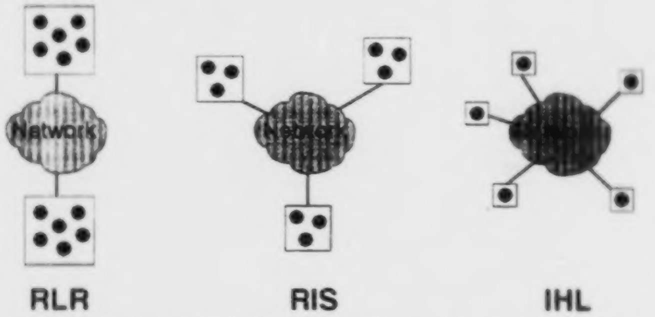

Figure 2: Distribution and individualisation degree of the three main modules

3.1 Remote Lecture Room (RLR)

In the Remote Lecture Room scenario large lecture rooms are connected via a high speed network such as ATM. Each lecture room is equipped with state-of-the-art audio and video facilities and one high performance multimedia workstation. Lectures that are part of the common course of studies of the two universities are exchanged synchronousely between the two lecture rooms. The transmission runs in an interactive mode and we are using the following streams of information:

- The *teacher's video and audio stream*: captured by a local camera and a microphon respectively, these are connected to the workstation. The signals are then digitized, transmitted to the remote lecture room, and

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projected by a large-scale video projector.

- The *local student's video and audio stream*: are dealt in the same manner, namely the remote students are also able to receive the local student's video.
- The *remote student's video and audio stream* are transmitted vice-versa.
- *Electronic slides of the teacher* and other course materials such as animations, graphics and digital videos are transmitted also by using an electronic whiteboard and shared tools.

3.2 Remote Interactive Seminars (RIS)

In this scenario, small groups of participants are distributed across a few seminar rooms which are also connected by a network. In seminars, students have to formulate and present a report about a certain topic. This kind of learning includes two types of communication:

- *asynchronous*: during the formulation of the report students use e-mail or newsgroups for group work.
- *synchronous*: students are using video conferencing systems to transmit their presentation to the remote groups and use CSCW tools for their group work.

The equipment of the seminar rooms is comparable to the RLR module if somewhat less lavish.

3.3 Interactive Home Learning (IHL)

The IHL module is aimed at the maximization of the geographical distribution degree of all class participants. Each student learns at home in front of his PC. The teacher and the students are connected by low-bandwidth links e.g. ISDN. Asynchronous learning comprises of the retrieval of recorded lectures, lecture notes, work with CBT software and the participation in electronic discussion groups. In the synchronous mode, students should be able to participate interactively and live, in lectures and in seminars whilst being at home. The major goal of IHL is the achievement of better preparation for exams and a further intensification of co-operative learning.

3.4 Teachware Authoring (TWA)

For one hour of CBT approximately 200 hours of developement time are required [Kawalek 95]. Novel approaches such as „Authoring on the fly“ [Bacher & Ottmann 96] seem very promising for reducing the time in effort. We propose the following approach to enhance efficiency in the developement of teachware:

1. *Pre-Authoring* is the preparation of lectures, including all required media sources (slides, images, etc.)
2. *Recording*: The course is given in one of the instruction types RLR, RIS or IHL. The resulting media streams (e.g. audio, video, shared tools, etc.) are then digitally recorded.
3. *Post-Authoring*: Based on the materials obtained from the first two phases, a complete multimedia document, enriched with further multimedia components (e.g. animations) is then produced.

3.5 Multimedia Database Support (MDS)

Storage and retrieval of multimedia teaching material requires multimedia databases. They have to be capable of supporting both discrete media such as text and continuous media such as audio and video media. We propose to combine the capacity of scalable video servers [Bernhardt & Biersack 94] (concerning storage space and real-time requirements) with the ability of hypermedia database systems.

3.6 Telecommunication Support (TCS)

The objective of TCS is to provide the network infrastructure and the communication software required by our three main modules. The live transmission of instruction is based on existing video conferencing systems, which though prove to be less than sufficient for the purpose of teleteaching. We are currently developing a TCS package, which supports group communication mechanisms such as floor control, „putting up hands“, and

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telepointers [Fluckiger 95]. These mechanisms mainly improve social awareness and the organisation of the geographically distributed group of people working together via computer networks.

4 Pedagogical and Psychological Integration

Quite obviously, the „marriage" of distance and „real world" education [Fig. 1] requires not only technical solutions, but an adequate organisational and pedagogical framework. The pedagogical and psychological importance lies in guiding the users of the SMDL (teachers and students) through design and usability questions. Teachers will need advice in how best to design course materials and handle the technical properties. Students will need guidance in using the material and technical properties, and performing effective learning strategies in both self-regulated and collaborative learning phases. In planning, designing, and sequencing the subject matter of the modules of the SMDL [Fig. 1] we will rely on prescriptive instructional models. The „Learning Cycle" model [Mayes et al. 94] suggests technological and medial options to support the very instructional aims characterizing each of three phases of an ideal learning process (conceptualisation, construction, and dialogue). As each phase corresponds losely to a certain type of instructional setting (lecture, seminar, etc.) the model might prove a valuable framework for instructional advice. We plan to provide our advisory instructions in the form of „learning-by-doing" manuals in combination with (E-Mail-based) tutoring. A thorough pedagogical and psychological evaluation of the SMDL is indispensable for a sound pedagogical and psychological consultation. Our quasi-experimental studies using a multi-method approach are designed to compare local and remote student groups or likewise users and non-users of multimedia documents and programmes.

5 Implementation

The „TeleTeaching" project currently runs in its pilot stage and in the beginning we implemented the RLR module between the University of Mannheim and Heidelberg as described in Chapter 3.

- *Network technique*: The computing centers of the two universities are connected via a 34 Mbps ATM link [de Prycker 93]. Each lecture room is connected to the computing center via a dedicated 10 Mbps Ethernet segment and the university's 100 Mbps FDDI ring. We are currently using the Internet protocol stack on top of ATM, Ethernet and FDDI. This proved to be rather disadvantageous because resource reservation is not possible with IP, consequently, we had to share the link with other network traffic between and within the universities (see Chapter 6). However, to provide high quality video and audio streams a certain quality of service by the network, e.g. a guaranteed bandwidth, is required.
- *Application software*: Currently, we are using the Mbone toolset (Multicast Backbone) for the transmission of lectures, namely *visual audio tool (vat)*, *video conferencing tool (vic)*, *whiteboard (wb)* and *wbimport* [Macedonia & Brutzman 94]. Vat allows for the transmission of telephone quality audio signals using e.g. PCM encoding. Vic provides coding, compression and transmission of captured video streams. It supports compression schemes such as H.261 or M-JPEG. The slides or the multimedia teaching materials are sent to the remote site by using wb. Wb is a shared drawing tool which allows the display of postscript pages to the remote students. Combined with wbimport it offers a comfortable access to all postscript slides used in a lecture. Furthermore, we developed a small tool that allows the electronic „putting up of hands".

6 Experiences

6.1 Technique

In the summer of 1996 we transmitted a complete course about computer networks consisting of 22 sessions from Mannheim to Heidelberg for the first time. From the technical point of view our experience was rather positive. Specifically the software proved to be very stable because we had no single failure. We have been able to minimize the preparation and set-up time of a transmission, due to the fixed installation of all required facilities in the lecture rooms. It is now possible to start transmission within 15 minutes. We did not encounter problems with the whiteboard, however problems arose with the audio and video streams. For the video channels we used the H.261 encoding standard with a frame rate of approximately 16-17 fps corresponding to a bandwidth of about 500 to 600 Kbps. Higher rates could not be achieved with the software codec (coder-decoder) on the multimedia workstation. Thus, we reduced the frame rate of the remote students to 1 fps because the teacher's video is most important. Using the built-in hardware M-JPEG codec allows for frame rates of about 25 fps in TV quality but consumes up to 4 Mbps of bandwidth. We discovered that such a high bandwidth overloaded the connecting network and thus produced severe audio problems e.g. drop-outs. Even when using low-bandwidth video (H.261), from time to time we encountered audio and video drop-outs for a duration of about 2-3 seconds. Experiments showed that during these phases data losses of approximately 87% occured. The reason for this is mainly that it was impossible to reserve a guaranteed bandwidth on the network connection. Heavy network usage of other network users thus produced data losses. Another reason for the drop-outs is the high amount of active network components (such as routers and bridges) on the network connection between the lecture rooms. These components, not thought to transfer multimedia data, additionally introduced delays and losses. Since we were successful in solving some of the problems, the first experiment with RLR can also, from a technical point of view, be considered as rather successful.

6.2 Pedagogical and psychological evaluation

We carried out four surveys, one at the beginning, two in the middle and one at the end of the semester. The two middle surveys were carried out before and after the lecturer temporarily moved from Mannheim to Heidelberg. With this variation it was possible to observe both student groups under the two quasi-experimental conditions. Moreover, the lecture was accompanied by observations and interviews on both local and remote sites. Data was gathered on motivation, concentration, problems in understanding, acceptance and technical aspects etc. In addition, the lecture was evaluated using a standardized questionnaire [Rindermann & Amelang 94].

6.2.1 Students

The data is not yet fully analysed and as yet only descriptive statements are possible. First results suggest, that

- the students' ratings concerning the quality of the lecture are rather high in all criteria.
- both local and remote students were able to concentrate and understand the content of the lecture.
- audio combined with the whiteboard were most important for the transmission of learning contents concerning understandibility, whereas video mainly intensified the social enrolment [see Bacher & Ottmann 96], [Kawalek 95].
- the remote students accept the new technology, but were discontent with some audio and video problems in the beginning of the semester.
- there are differences between the student groups, in that Mannheim students constantly give lower ratings in acceptance of the technology. This tendency becomes even more salient in the data gathered whilst Mannheim was in the remote situation. Interview data suggests that this is mainly due to the higher level of noise in the lecture room with the lecturer not being physically present and hence the fear of not understanding all the relevant information.
- the interactivity was low on both sites. Questionnaire data suggests that students did not feel the need to pose more questions or engage in discussions on both sites, which is quite usual for lectures. Remote students, especially, felt that the threshold for starting an interaction was quite high because they would have to use a microphone and interrupt a distant lecture.
- organisational and informational shortcomings might be the core-problems in setting up SMDL. On average, only about 9 students in Heidelberg (as compared to about 90 in Mannheim) regularly attended the lecture. Interview and questionnaire data suggest, that this might be partly due to the fact that the field covered by the lecture was a specific field in Computer Science, hitherto only established as an original course of studies at the University of Mannheim. Heidelberg students attended the lecture as a subsidiary subject for physics or mathematics lectures. But there is also evidence especially from interview data, that most of the students merely „stumbled" over the lecture in the WWW or were informed by word of mouth. Moreover, the students appeared to be quite unsure about whether there was a possibility for passing an exam in the field covered by

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the lecture. However, it was highly relevant for Mannheim students. Most of the Heidelberg students did not know about the universities' formal agreement.

6.2.2 Lecturer

As the lecturer was an expert in Computer Science, he become used to using the technology quite easily. The situation of speaking in front of a camera to students not physically present, made him feel rather uneasy at first. In a more interactive instructional setting lecturer-training might be required, especially if he/she is not as accustomed to using computers for teaching purposes as the „pioneer-lecturer".

7 Conclusion

We presented a Semi-virtual Multidimensional Distance Learning System (SMDL). The three modules - Remote Lecture Room (RLR), Remote Interactive Seminars (RIS), and Interactive Home Learning (IHL) are the basis of a semi-virtual university. The initial phase of the SMDL was successful from a technical point of view. The new technology appears to be accepted by students, but it is capable of improvement as far as interactivity is concerned. The fact that Mannheim students constantly rated the experiment lower in most of the criteria might be due to different motivational orientations. The lecture was very important as the Mannheim students had to pass exams in their chosen fields of study. Any technical „fooling around" might be at their expense. A major pitfall for the success of the approach can be seen in insufficient organisational efforts. Therefore, analysing the demands of the teleuniversity in advance, in accordance with comprehensive information and marketing efforts, might prove to be the key to getting SMDL started. Recently, we have begun to conduct seminars in the RIS module and first observations are promising. The IHL module has also started by creating the organisational framework. Furthermore, we are now developing more adequate and user-friendly teleteaching and -learning software, which should be suitable for all modules.

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Development of the Computer Skills Metric for Windows

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Abstract:. This paper describes the development of a metric for Windows 3.x computer skills. The metric consists of a Usage and Skill Level Inventory and a Computer-based Skills Test. The Usage and Skill Level Inventory rates previous experience of using Windows 3.x programs and generic Windows skills. The Computer-based Skills Test is a set of trivial tasks designed to reflect Windows skill. The two parts independently assess self-declared experience and actual performance in Windows. The results of the evaluation of the metric so far suggest that for the group of higher education teaching staff there is a significant ($P<0.05$) correlation between Inventory score and performance in the Skills Test, whereas for students the correlation is non-significant. Explanations for this disparity are explored and recommendations are made to improve the metric.

Introduction

Work at University of Wales Institute Cardiff in hypermedia authoring has focused on the development of ***SHAPE***© - a **S**emantic **H**ypermedia **A**uthoring **P**ackage for higher **E**ducation which is designed to use concept mapping techniques to reduce the cognitive overhead of expressing a knowledge domain and produce a skeletal hypermedia knowledge corpus which can be 'fleshed out' by the addition of multimedia materials, e.g. text, graphics, video clips [Elliott et al 1995], [Elliott et al 1996]. ***SHAPE***© has currently been produced as an interface to the standard authoring package Asymetrix ToolBook™ which is a Windows-based product. Thus, in evaluating the ease of learning and ease of use of ***SHAPE***©, one runs into problems associated with the transferability of Windows skills. Windows, like other graphical user interfaces (GUIs) e.g. Macintosh Desktop, was specifically designed to provide a consistent user interface using menu symbols or names already familiar to the user to facilitate more rapid learning [Foley et al 1994] and thus Windows experience/expertise was an independent variable which needed to be controlled, since subjects with a greater Windows experience should be better able to engage with a new Windows-based program more rapidly.

This paper describes the development of a metric for assessing an individual's Windows skill. The metric, Computer Skills Metric for Windows (CSM(Windows)), is defined here as a person's transferable skill of using Windows and Windows-based packages, excluding Windows 95 and Windows 95-based products on personal computers. Van Vliet et al [Van Vliet et al 1994] point out that there have been a number of attempts to develop tests to measure computer skill, although each is intended for particular subject group and computer skill. In their experiment Van Vliet et al found that self appraisal tests used alone can introduce a leniency bias where subjects inflate their own skills and Van Vliet et al concluded that to get a true picture of skill, a number of different measures should be triangulated to give a more accurate assessment.

Definition of Computer Skill

A simple definition of skill has eluded both behavioural and cognitive psychologists although defining characteristics of skill include: a wide behavioural domain in which behaviours are assumed to be complex; an understanding that skills are gradually learned through training; and attaining a goal is dependent upon motor behaviour and processes. Gattiker [Gattiker, 1992] categorises the meaning of the term 'skill' in relation to its potential ease of transferability and reasons that computer-interface-skills have low transferability.

Each individual is equipped with innate motor behavioural abilities and an ability for cognitive processing (abstract reasoning, problem solving, etc.) which they can develop generally or achieve specific tasks/jobs.

CSM(Windows) measures both motor-behavioural (e.g. mouse and keyboard) skills and cognitive process abilities (e.g. finding/knowing the correct icon, command sequences, menus). Subjects with a high skill level in Windows generally, should be able to rapidly orient themselves in an unknown Windows program, provided that the objective of the unknown program is fairly easy to understand.

From observations of four cohorts of students taking a course in basic computer skills over a four year period a list of elementary skills for using Windows and Windows-based packages has been compiled:

Psycho-motor skills:	Cognitive Processes:
• Single click with left mouse button • Double click with left mouse button • Drag and drop • Select from button types, menu options, dialogue boxes as required • Input via keyboard	• Successfully carry out a sequence of the above activities to complete a task e.g. draw a shape on the screen • Learn a sequence of the above activities to complete a task • Search for assistance to carry out an action and follow instructions • Understand/create/update/delete file and catalogue structures • Understand salient aspects of hardware: hard drive; floppy drive • Understand the 'computer processing paradigm': the limitations of computers; their apparent pedantry; and the necessary sequence of operations

The CSM (Windows) Metric

The metric is computer-based and has two parts: a Usage and Skill Level Inventory, and a Computer-based Skills Test (a battery of 5 exercises that aim to test the list of motor-behavioural and cognitive processing skills above). The philosophy behind the inclusion of an inventory and a test-battery was that each part could help validate the other.

Usage and Skill Level Inventory

This is designed to find how extensively subjects use Windows and Windows-based applications and is completed by the subject under the supervision of the researcher. The inventory asks salient questions about the subject's experience in terms of experience of using Windows and Windows-based applications. It is recognised that even if a subject uses Windows all the time they may still have a low skill level.. The last inventory question asks subjects about their perceived skill level is on a scale from None to Very High.

Computer-based Skills Test

The exercises are monitored exercises which incorporate typical Windows-based tasks. Whilst it is recognised that the exercises also test other cognitive factors, such as problem solving skills, the tasks are designed to be trivial as possible with simple instructions printed on the screen to reduce cognitive overhead. The underpinning hypothesis is that subjects with prior Windows skills should complete more of the exercises more quickly than those without. CSM (Windows) calculates the time taken and the percentage of each exercise completed.

Use of help facility

A standard help facility is available throughout the exercises to help subjects complete them although no help is given on basic Windows skills. Use of the help facility is seen as an important Windows skill so any use of the help menu, particularly in exercises 3, 4 and 5 which are more complex exercises are counted and registered by the system.

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The Exercises:

The exercises attempt to measure different aspects of Windows skill however it was anticipated that there would be some overlap of these aspects. It was therefore of interest to see the extent to which the results of the exercises co-varied. Significant covariance between the exercises would suggest that one exercise could be substituted for another if necessary. The table below explains what each exercise is designed to measure.

	Tests ability to:
1	'Drag and drop'. The cursor changes when dragging the shapes which is a familiar Windows requirement. If subjects do not know how to 'drag and drop' they will not be able to complete this exercise.
2	Click to move the cursor into the text entry box and keyboard knowledge. Subjects are asked to copy type a short paragraph that includes some of the less commonly used keyboard characters that require the use of the shift key, etc.. The time to complete this exercise should be directly related to typing ability (for non-typists). The program measures any mistakes that subjects make in carrying out the task.
3	Construct objects on screen, using a series of commands and pull-down menus / tool-buttons / mouse - activities.
4	Carry out a sequence of activities using a command-driven interface. This exercise attempts to test a subject's understanding of the computing paradigm, i.e. the logical sequence of activities and the need for precision in syntax in specifying an action/command. Subjects with a background in general computing should be able to carry out this test better than those who without.
5	Carry out a bogus task using a number of standard Windows features: double-clicking; restoring and minimising objects; using option buttons and sliders; selecting files. Although subjects will not understand the task they should, if they are proficient at using Windows, be able to carry it out. CSM (Windows) measures which elements of the exercise has been completed

Procedure

CSM (Windows) has been used by 97 subjects to date, 74 first year students who had just completed a course in basic computer skills and Information Technology and 23 higher education lecturing staff. The program was administered to the students in a computer laboratory and they were told that the results were confidential, would only to be used for research purposes and would have no effect on their assessed mark for the course. The program was administered to lecturing staff in a similar fashion with the assurance that the results were confidential and would be used for research purposes only.

Results

The results are presented as a comparison between the two subject groups because of the differences observed between them.

Reliability

A Cronbach alpha test was carried out on the two parts of CSM(Windows) and the results showed that the Inventory was reliable, probably because it has so many component elements, whereas the exercises are less reliable, probably because there are only 5 elements.

Usage and Skill Level Inventory

Table 1 shows the median and interquartile range (IQR) for experience for the use of Windows and Windows-based programs for staff and student groups. The higher the median score the higher the experience and self-declared expertise in that area.

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	Student				Staff			
Windows Program:	Usage (Median)	IQR	Declared skill (Median)	IQR	Usage (Median)	IQR	Declared skill (Median)	IQR
Word-processing	3.00	1.00	3.00	1.00	3.00	2.25	2.50	2.25
Spreadsheets	1.00	1.00	2.00	1.00	1.00	1.25	2.00	4.00
Databases	0.00	1.00	1.00	2.00	0.00	1.00	0.50	2.00
Email	1.00	2.00	2.00	3.00	2.00	2.00	3.00	2.00
DTP/Drawing	1.00	1.00	1.00	1.00	0.50	1.25	1.00	3.25
Windows utilities			1.00	2.00			1.00	4.00
Other programs	-	-	0.00	0.00	-	-	4.00	5.25

Table 1: Median and IQR values for usage of typical Windows applications be staff and students

The mean overall accumulated inventory score for staff was 38.59 with a standard deviation of 25.45 and for students the mean was 28.59 with standard deviation of 10.05, the difference between the two groups was not significant (Student's t test. t=1.8, P=0.085).

Computer-based Skills Test

Table 2 Compares the mean times and mean fraction-completed of each exercise by staff and students.

	Time to complete exercise				Fraction-completed for each exercise			
	Staff	Student	Comparison between groups		Staff	Student	Comparison between groups	
	x±SD	x±SD	t	P	x±SD	x±SD	t	P
1	22.41 ± 12.25	21.82 ± 6.70	0.21	0.83	1.00 ± 0.00	1.00 ± 0.00	-	-
2	100.80 ± 50.99	101.20 ± 28.60	-0.05	0.96	1.00 ± 0.00	0.99 ± 0.09	0.67	0.50
3	100.05 ± 90.98	127.80 ± 58.92	-1.70	0.09	0.55 ± 0.51	0.75 ± 0.43	-1.71	0.10
4	222.45 ±195.19	349.15 ±236.80	-2.29	0.02	0.55 ± 0.51	0.45 ± 0.49	0.79	0.43
5	91.63 ± 46.76	289.95 ±185.56	-4.95	0.00	0.50 ± 0.51	0.47 ± 0.30	0.28	0.78

Table 2: Mean values of times and fraction-completed for each exercise for the two subject groups and Independent samples t - test values comparing the two subject groups

Table 3 shows the Pearson correlation coefficient between the mean times and fraction-completed for each exercise and the inventory score:

	Students				Staff			
	Time		Fraction-completed		Time		Fraction-completed	
Exercise:	r	P	r	P	r	P	r	P
1	-0.27	0.02	-0.11	0.35	-0.63	0.00	-	-
2	-0.12	0.29	0.1	0.39	-0.48	0.02	-	-
3	-0.201	0.86	0.16	0.16	0.14	0.54	0.73	0.00
4	-0.02	0.89	0.10	0.37	0.35	0.10	0.73	0.00
5	-0.005	0.96	0.16	0.17	0.17	0.45	0.56	0.00

Table 3: Pearson correlation coefficients between the mean times and fraction-completed for each exercise and the inventory score for the two subject groups

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Correlations between the exercises

Some of the between-exercise correlations for exercise times for staff (between exercises 1 and 2($r=0.66$), 3 and 4 ($r=0.80$) and 4 and 5 ($r=0.45$)) and students (between exercises 1 and 2 ($r=0.29$), 2 and 3 ($r=0.28$), 2 and 4 ($r=0.31$), 3 and 4 ($r=0.31$) and 4 and 5 ($r=0.28$)) are significant ($p<0.05$). There were very few significant correlations between the exercises for fraction-completed.

Use of the help facility

Table 4 below shows the mean number of times help used and its correlation with the inventory score for each subject group

	Staff	Students
Mean usage of help facility	4.30	6.55
Standard deviation of usage of help facility	6.50	6.62
Correlation of use of help with inventory score	-0.09	0.03
Significance of correlation of use of help with inventory score	0.67	0.80
Correlation of use of help with overall completion Rate	0.39	0.22
Significance of correlation of overall completion rate	0.07	0.06

Table 4: Mean number of times help used during exercise and correlation with the inventory score for each subject group

Discussion

The staff inventory scores covered a wider range of values than the students even though the sample was smaller. This is not surprising since the students (mean age 20) represent a more homogeneous group with less overall experience of computers. The application skills were similar for both groups, however staff had greater experience in email, other Windows programs and Windows utilities. The responses to the questions appeared to be a fair reflection of both groups computer experience. The differences between the overall inventory scores was not significant because of the wide variation of the staff group and the homogeneity of the student group.

The differences between timings for exercises 1 and 2 for staff and students was not significant, however it was for the other exercises. The differences between the fraction-completed for staff and students for all exercises were not significant, indicating that although their timings for the exercises differed they did not complete anymore. All subjects completed exercise 1 and the timings correlate with the inventory score significantly for both groups, indicating that exercise 1 is a measure of a subject's Windows expertise. Students spent considerably more time trying to complete exercises 3,4 and 5 than did the staff. This may be because the students felt that they were 'competing' with their peers and did not want to be seen to have failed whereas the staff seemed more circumspect about their performance. Another reason might be that since the average age of the staff group was greater ie less 'attuned' to computers and the group had proportionally more low inventory scores so they were less confident and gave up quicker. Another confounding factor could be that this group of students had just completed an introductory course in using Windows-based programs. These factors need further study.

The times taken to complete the exercises 1 and 2, 3 and 4, and 4 and 5 co-varied significantly in both groups. There was a significant correlation for fraction-completed for the student group only between exercise 4 and 5. The picture for the staff group is very different with significant correlations between exercise 3, 4 and 5. These covariances point to overlaps in the skills being meaured and will require further analysis isrequired to explain the observations.

Students were more inclined to use the help facility than staff suggesting that they were again more confident in using computers. There was no correlation between use of the help facility and inventory score and use of help and completion rate for either group, suggesting that use of help is idiosyncratic and does not have a bearing on the success of subject in a new computer situation.

The correlation between student performance in the exercises and their inventory score was not significant, but it was for staff. Accounting for this discrepancy is difficult - if the exercise were badly designed one would not expect a high correlation for either group. If the exercises are viewed simply as problems, one might expect subjects with good problem solving skills to do better. A measure of the students' generic problem solving skills is not readily available, however performance in an assignment not closely related to computer skill has been made available. This assignment required students to analyse the information technology needs of a known organisation. The correlation between their performance in this assignment and the fraction-completed of the exercises is significant ($r=0.33$, $P=0.005$). Interestingly there are no significant correlation between their assignment mark and the inventory scores, use of the help facility and the times spent on each task, suggesting that it was the students' problem solving skills that largely dictated their success in the exercises and not their experience in using computers. Subjects were asked to rate their overall skill from none the very high in using Windows, this correlated significantly for both groups with the inventory score (students $r=0.66$, $P=0.00$, staff $r=0.93$, $P=0.00$)indicating that their answers were consistent and supported by the reliability analysis.

Conclusions and further research

Both students and staff seemed to be honest in their answers to the Usage and Skill Level Inventory which reliably reflects their usage and skill in using Windows and Windows-based packages. Although, as [Von Vliet et al 1996] note, there is a danger of an inflationary bias in the results of self-appraisal tests if they are to be used for a formal evaluation of performance. There was a good correlation between staff inventory scores and their performance in the exercises but almost none for the students. A possible explanation for this may be that students are more comfortable with computers than staff, are more tenacious and more willing to experiment. Another reason might be that Windows has become transparent to the students and it is only their problem solving abilities that are being assessed.

The degree to which Windows is transparent to students and the exercises only measuring problem solving skill needs to be explored. The co-variances between the exercises needs to be further studied to discover what are the overlapping components of Windows skill. The lack of correlation between the use of the help facility and performance in the exercises for either group is a salutary lesson for help facility designers and could be investigated further.

CSM(Windows) will be re-examined and refined following this initial evaluation, but the usage and skill level, inventory has been found to be a good measure of a subject's experience of Windows.

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Managing the Infrastructure for Telecommunications Based Education in Australia

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Abstract: The Internet is arguably the most important development in educational technology in recent years. Major changes in the use of the Internet within universities presents many challenges for the management of IT infrastructure. This paper reports the results of a survey of IT Directors of Australia's 38 universities. The survey addresses aspects of provision of Internet services both on and off-campus. It analyses the varying strategies that have been adopted in meeting demands for services such as modem banks and laboratory access. The paper shows that there have been rapid changes in the quantity and quality of services over the last two years. It discusses the near universal concerns of IT managers about the impact of the Internet on cost structures and on their ability to continue to provide more traditional services.

Introduction

It is widely accepted that information technologies in general and the Internet in particular are an increasingly important element of the teaching/learning environment of Universities. The impact of information technology is leading to fundamental change in the nature of the University. Eli Noam, Director of the Columbia Institute for Tele-Information at Columbia university sees that the application of IT making the need for self-reform in universities an urgent task. Such reform:

> ... *may include a far-reaching structural administrative reorganization, breaking up the university into its component functions - credentialing; guidance; knowledge generation; instruction; and housekeeping. There will be a significant outsourcing of the latter two functions. There will also be an export of electronic courses beyond the traditional student population. In course provision, we will see much less of the traditional lecture system, which is a very inefficient way to accomplish the information transmission function of education. We will also see, in successful universities, an expansion of the guidance function, more of the tutorial, hands-on, mentoring-type activities that direct human contact provides best.* [Educom Staff, 1996]

He sees that the impact of information technology will particularly fall on the larger, publicly funded universities. [Hamalainen, Whinston, & Vishik, 1996] assert that "as perhaps the world's largest information industry, education is set to adapt a new just-in-time, on-demand approach to delivering its products through virtual universities by way of the Internet administered through the technology of electronic commerce". A number of models for the production and distribution of education are discussed. The impact of new models of networked empowered education will lead to changes not only in the delivery of education but also in more prosaic areas such as payment systems.

The management of the Internet and IT in Universities

Not only are academic planners seeing major changes in education arising from the Internet. Students are increasingly demanding access to Email and the World Wide Web. These tools are firmly embedded in their learning experiences but perhaps more importantly, are a well established part of their popular culture. A key element in the response of the University to these changes will be the planning and management of Internet infrastructure development. Depending on the infrastructure model adopted there will be implications, such as the transition from traditional modes of face-to-face teaching to an Internet enhanced model, for the 600,000

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students currently enrolled at Australian universities. These changes are against a background of constrained University budgets.

A linked array of possible activities are involved in the creating the Internet enhanced teaching and learning environment. These include the preparation and delivery of materials by faculty, the access to wider network resources and the use of those resources by the student body. In addition, students and faculty interact in a number of ways. These are shown in [Figure 1]:

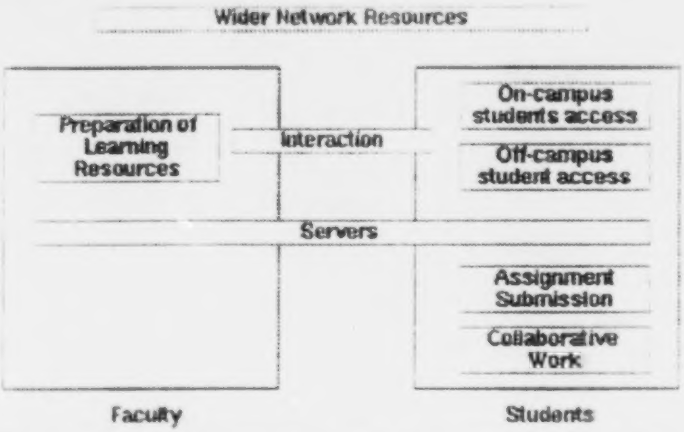

Figure 1: Model of the Internet enhanced teaching and learning environment

This mix of services can almost be seen as a Rubik's cube. Initially services were provided only on-campus and only to staff. This is represented by the front, top left hand element. A very limited number of Universities have gone on to develop an infrastructure which extends provision to all elements of the cube with an example being Boston University's Project Agora (see EduPage, 24 June 1996). Other Universities have adopted an infrastructure which supports only some elements. The purpose of this study is to analyse the response of Australia's universities to these changes.

The Survey

Universities in Australia, as elsewhere, are grappling with tremendous growth in the demand for access to the Internet, from students and staff; exponential growth in Internet traffic from their campuses; demands for alternative access points to the network around the campus and for the provision of off campus services for staff and students. The situation is highly fluid with Universities adopting many different models. There has been no comprehensive mapping of the provision of services, the management strategies and the forward projections for meeting these demands. This study reports the results of a survey of all 38 Australian Universities in terms of their present Internet provision and their planned provision in both the short and long term. The target population was Australia's 39 universities, two of which are privately funded. For full names and contact details the Australian University Vice-Chancellors' Committee maintains a link to all university web sites at `http://www.avcc.edu.au/uniwebs.htm`

The survey was approved and then distributed by the Committee of Australian Directors of Information Technology (CAUDIT) (`http://www.curtin.edu.au/other.caudit/information/`) with the expectation that directors themselves would complete the details.The survey took the format of approximately six screens of a World Wide Web mounted form. The form contained 86 questions of which 59 were "click and select" responses and 27 involved "type in text boxes" responses. Data submitted on the form was processed by a CGI script and then subsequently analysed in spreadsheet and statistical packages.

Reminder notices were sent via email on two occasions and within eight weeks from the release of the survey in mid-December 1996, a total of 29 responses (74%) were received. In comparison with a similar mailed questionnaire, this response rate was high. The Web format also provided flexibility in the design of the questionnaire and delivered the data in an electronic format ready for analysis.

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Results

Introduction

The 29 responses received via the Web were representative of the range of size and geographic locality (city versus regional) of Australian universities. Further, the IT directors were diligent in that the surveys were, with a few exceptions, complete. This was a function of the design and return mechanism of the survey. In the following sections we analyse the results from the major sections in the survey.

University IT Planning

We asked universities for details on whether they had developed formal plans for Information Technology and if they had, the date on which the most recent version was published. Seventeen (17) had developed plans with 12 either not having plans or in the process of developing a plan. Most of the plans were current for 1996 but a couple dated back to 1990/91. Our survey data indicated that none of the plans were available on the World Wide Web.

Undergraduate Laboratory Connectivity

A major focus of the survey (43 questions) was the provision of Internet services for undergraduate students. All universities provided undergraduate students with email accounts. Some 18 of the universities automatically create the students' email accounts. The remainder create the students' accounts upon request. Only one university allowed the students to keep their email accounts after graduation. It is perhaps surprising that more universities have not recognised the potential of long term electronic linkages between their recent alumni and the University. This is a statistic that may change rapidly in the next few years.

Most universities manage their student email centrally. A total of 19 universities provided a response on the level of hard disk storage provided to students for their email. The minimum storage provided was 0.1mb with the largest being 10mb. The median storage supplied was 1.5mb. One large city university dispersed the email down to local area networks within the faculties.

Half of the universities (14) allow students to generate their own World Wide Web pages. This is a higher proportion than might have been expected given the recent arrival of the Web. Ten (10) of these provided details of the amount of storage provided to students to store their Web pages. Storage levels seemed to be generous with the minimum allocation being 1mb and the maximum 10mb per student. The median storage facility was 2mb. These levels of storage allow for quite complex student home pages. Again, for the single large city university discussed in the previous paragraph, storage was delegated down to the faculty level.

All but two of the universities had Internet connectivity in their undergraduate teaching laboratories. One of these indicated that connectivity would be complete in 1997 and the other stated that connectivity would be coming at a later stage. It is presumed that these universities would have a mixture of labs that were and were not connected to the Internet. All but one of the universities providing Internet access to the undergraduate laboratories also provided Telnet access.

All universities with Internet access also provided World Wide Web connectivity. This is again surprising given the recency of the technology and the hidden cost implications. While the essential browser software is freely available for Universities there are other financial implications. PCs that would have had perhaps only 4 or 8mb of RAM in the past, must now be upgraded. The university network backbones must be ramped up to meet new demands in terms of protocols and volumes of data being transferred.

The ability of the Web to readily incorporate multimedia features of sound and animation has been a major factor in its rapid diffusion. Some of the most interesting material of educational value on the Internet is in RealAudio and other audio formats. The survey sought information on the capability of computers within the laboratories to play audio. Eleven universities had laboratories which were currently "sound capable" with a further three universities planning to add this feature in 1997. Seven universities were planning for this feature at a later stage and a similar number were not considering this provision at any time. Of those that currently had audio capabilities, only three reported that headphones were provided in the laboratories. Clearly this statistic will increase in future years.

The survey asked if the Web browsers were capable of displaying animation (e.g. Shockwave or Java). Fourteen (14) reported that these features were supported, with 12 advising that this would be added in 1997 or later. This is a strong indication that there is a priority in upgrading Web browsers to support the most recent advances in Web technology.

Undergraduate Non-laboratory Connectivity

The survey asked a number of questions about connectivity outside the traditional computer laboratories within the University campus. Twenty-one universities currently have Internet access in the library with a further two major city universities planning to add access in 1997. A further five universities plan to add access at a later date. Interestingly, the integration of library functions and the Internet is not seen universally as being a priority.

An increasing number of students are acquiring laptop computers. The survey asked for details on the provision of high speed (Ethernet) "docking stations" for laptops. Four universities currently provide this service; another university plans to add the service in 1997 and 16 at a later date. Surprisingly seven universities have no plans for docking stations.

Most universities in Australia have residential colleges or some other form of student residences. The survey sought responses on the number and nature of connectivity supplied to these facilities. Twenty-five universities currently provide at least some residences with network access. Of these ten provided less than 100 connections. Most connectivity was via Ethernet with only two universities reporting that connectivity to the residences was over a dial up service. When questioned about the issue of limiting individual access times, twelve universities indicated that this was already current practice with a further 10 universities indicating that it was under consideration. Clearly the trend is to limit the load on the network.

Off-Campus Availability

Australian universities service a relatively high proportion of part-time and external (distance education) students. The survey therefore addressed a number of questions on dial in access. In 1996 only four universities offer more than 200 modems and seven provide less than 50. By commercial ISP standards none of the universities are providing modem banks of a sufficient size to allow "unlimited" access.

We tested the relationship between size of institution and the number of modems supplied for student dial-in access. As can be expected, there was a statistically significant relationship between these variables. A one-way ANOVA showed that size of institution could only explain 29% of the variation in the dependent variable of the number of modems. It was significant at the 99% confidence level. Looking at the data, some interesting patterns can be observed. Some smaller universities have clearly made substantial investments in modem banks. At the other end of the scale there are very large universities which have apparently made decisions that they can provide only token access. This is illustrated by four universities. Summary information on these selected institutions is shown in [Figure 2]:

University	Type/Size of University	Students	No of Modems
A	Capital city, small to medium size	5-10k	101-150
B	Capital city, large	15-20k	0-50
C	Regional, small to medium size	5-10k	> 200
D	Regional, medium to large	10-15k	0-50

Figure 2: Provision of Modems by Selected Universities

The pair of city universities have adopted different strategies. University A has a large number of modems for its relatively small size. B has effectively decided not to provide modem access. In the regions, C would appear to have adopted a strategy that provides extensive modem access for students while D has adopted the reverse approach.

As might be expected there is a clear trend to provide modem banks that provide the highest speed of connectivity that current technology will provide. Thus in 1995 the majority of external modem banks had less than 25% of 28.8kb modems. In 1997 half the universities have only 28.8kb modems. This demonstrates that a relatively rapid response has been made to the bandwidth demand that is primarily being driven by graphical web browsers.

Modem dial-up protocols have been rapidly adopted within the University community. In 1995, 12 universities provided PPP access with 14 providing other forms of access such as SLIP and direct connections to minicomputers. In 1996 this had changed to 22 and 4 respectively.

Access to modem banks is a function of the demand and of supply factors including the numbers of modems provided and any limitations imposed on users' connect time. By 1996, 19 universities reported that limitations on student access time were in place. Another option to control student access which also reduces charges on Internet volumes to universities is to limit student downloads of data. Surprisingly, only six universities report that they limit downloads.

The survey also requested open-ended responses on the provision of Internet access to off-campus undergraduate students. The responses received are summarised in [Figure 3]:

Type of Provision	Number
No provision	8
Arrangements with Internet Service Providers (ISPs)	4
Modem pools at regional campuses	6
Dial in to central modem banks at student expenses	4
Other	2
Total	24

Figure 3: Provision of Off-Campus Access

A trend can be seen from these responses. The 6 universities which are providing modem pools at regional campuses are all either "network" institutions which have resulted from the merger of a number of smaller institutions or which have a substantial proportion of distance education students. For other institutions, encouraging students to gain access to the Internet via ISPs is increasingly popular and will be discussed in the next section.

High rates of growth of traffic are being experienced by universities in Australia as evidenced by the statistics shown at `http://www.avcc.edu.au/avcc/aarnet/trafrec/memtraf.htm`. This growth translates into higher charges to individual universities. The survey sought information on cost recovery. At present 6 of the 25 universities which answered this question were levying charges on off-campus Internet access by students in 1996. Of course, a number of those universities which are not making charges are also providing limited or no Internet access. Charging mechanisms varied widely. Annual charges ranged from $50 to $80 per annum. One university charges the teaching units for legitimate usage of the Internet and private usage is charged to the student. Considerable change in charges to students can be predicted to occur over the next year or two. The survey asked if the university was considering changes in its charging mechanisms in 1997. Fifteen (15) advised that they were considering changes with 10 not considering any change. These changes will result in 18 universities making charges for off-campus access in 1997 with 7 making no charge. This is an almost exact switch from the 1996 pattern. As one director stated, "we cannot face continued growth at 17% per month".

Moving students from dial up access provided by the university to Internet Service Providers (ISPs) is seen as reducing cost and potentially providing a better service to students. The cost of those services is then placed on the student. A variety of support for ISPs was evidenced. Some universities maintain lists of suggested or recommended ISPs. Others have formal relationships between the university and an ISP. Formal relationships were in place at 10 of 28 universities in 1996. Seven (7) of the universities that did not have such relationships were either actively pursuing this option or were ready to sign an agreement. One regional university reported that it had had difficulty in finding ISPs that could adequately meet its technical requirements across the country. One medium sized capital city university advised that it had rejected the ISP concept as it was too expensive for students. There was clearly no enthusiasm amongst the survey respondents to provide large scale off-campus access for students and especially for undergraduates.

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Discussion

The responses to the survey indicated that directors of IT feel that the Internet is creating many challenges for the provision of general and specialist computing services. The survey requested that they respond to the question "what is your single most important concern for Internet provision in 1997?". Sixteen of the 23 directors that answered this question said that the single most important concern was cost; or as one director of IT at a smaller university stated "Cost! Cost of data, cost of links, cost of machines capable of running the 'latest and greatest'". Another director said that desktop resources are being consumed for searching for information on the Internet with "less availability for previous desktop activities". Others were also concerned with an explosion in Internet activity for other than scholarly purposes. One director of IT at a large city university recognised that "we can develop a lot of what we have to offer using the Internet" but that there was "A lot of use [of the Internet which was] not for serious scholarly work, how can this be controlled?".

Another concern which was expressed by regional universities was the provision of access to distance students. The director of IT at a large provider of distance educaiton noted that a particular concern was "access for remote students (as opposed to those who are external)". The director noted that the "lack of equitable access in both cost and quality of connection appears to be impossible to overcome for many students". Equally, there was concern that the Internet was eroding the more traditional role of IT in universities. A number of directors stated that they considered that internal charging mechanisms within the university was the only solution to decisions on what resources were to be allocated to the Internet in the teaching and learning process.

The survey has shown some trends which might have been expected. Growth rates in usage of the Internet are clearly causing IT directors major management challenges. These are being responded to, at least in part, by moving undergraduates to ISPs - a solution which also removes concerns about the academic appropriateness of activities carried out on the Internet. A number of results from the survey are surprising, however. The rapidity in making Internet access universally available in the laboratories, the speed at which multimedia is being supported is perhaps surprising given constrained budgets.

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Cooperating Virtually about Virtuality : Promoting Interdisciplinary Efforts

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Abstract. We present a work in progress report of what may become our interdisciplinary-based standard for the construction of Computer Based Education (CBE) software within our Virtual University project [Tames 96] [Espinosa 95a]. Given our fast-paced workstyle, it becomes hard, if not impossible, to negotiate continuous, long lasting design meetings with several experts. These experts are faculty from diverse schools in our campus who contribute to the virtualization of a course [Espinosa 95b]. It has been proposed that the Internet become, using *Collaboratories* [Kouzes 96], a preferred means for bringing together people in situations similar to those experienced by our experts and ourselves. We suggest a theoretically sustained, but validated method for achieving a virtual cooperation using proprietary Internet-based Collaboratory software. These guildelines will allow us to reach more realistic [pedagogic and socially accepted] results in our project.

1. Introduction

We actually are in the third year of a project which aims at what we call the "Virtualization of the University" [Tames 96] [Espinosa 95a]. It includes the construction, and validation, of a series of educational software products. These are being tested at the high school and college levels. In it, the following premises hold :

1. The student must be trained to learn in an autonomous manner, developing analysis, synthesis, and evaluation skills, as well as :
2. Promoting a strong responsibility with respect to his/her learning process. [ITESM 96].

Firstly, we pretend that the current educational model used by ITESM stop being a "teaching-learning" one, that is, one in which the centerpeice is characterized by the instructor's teaching (ie. lecture) strategy, or *Teacher Model* [Boy 96], and the transfer of knowledge to the student. The new model emphasizes "learning". It is centered on the intentions of the student, his/her experience, and the involved metacognitive strategies [Nelson 92] [Morris 94] [Reeves 94].

Following this new model means that we will delegate onto the student the responsibility to administer his/her own learning scheme. This means that the resources he/she will need throughout the process are given, but will be accessed on demand as required based on a personal estimation. The instructor(s) will not interfere in these decisions.

It is our responsibility as educators, therefore, to facilitate the working (ie. Learning) materials in as many different ways as possible.

2. New Educational Paradigms

Adhering to this epistemological paradigm, a *Constructivist* [Reeves 94] one, has a series of social, cultural and pedagogical implications, besides computational ones :

1. The current educational focus is centered upon the *Instructivist* epistemological model [Reeves 94].
2. The development of computer software that conforms to the new epistemological model requires the concurrent introduction of validation and correctness criteria different to those traditionally applied by Software Engineering standards [Sommerville 92], and
3. Neither it is sufficient to reproduce the current educational materials *per se* using multimedia, hypermedia or virtual reality.

With respect to the first point, nowadays we shelter in the Instructivist epistemological model, which emphasizes the importance of goals and objectives derived from a domain where an expert dictates what is true and what isn't within the application. Such goals and objectives are categorized and hierarchically placed such that a linear model of progressive lower level to higher level steps is achieved. In our research, we tend to modify our educational schemes, trying to place them in an *intermediate state* between Instructivism and Constructivism. We attempt to provide a subjective construction of reality by a particular human being as he/she gathers experiences, does some processing on them, and incorporates metacognitive reflections to these results. No longer does the expert provide a complete truth about the real world. Our software designs take this into account.

We have just mentioned the word *metacognitive*. Therefore, with respect to the second point, the social impact this type of software designs have depend, to a great extent, on the psycosocial acceptance or rejection the [academic] community will feedback, as human validation parameters are taken into account [Reeves 94] [Morris 94]. Such parameters are extracted from the field of Cognition, and will be described later.

We now reach the third point. It is not possible to assume that we will succeed in the validation effort just by making use of the state of the art in distributed computing, such as the Java Technology [Espinosa 96d].

3. Teams again ?

The previous discussion leads us to make an attempt at reinforcing our teamwork capabilities. It is not enough anymore for the academy to work on educational virtuality on its own. We now propose collaborative work by the experts with people from support areas, such as a Virtual University Department [Vallejo 97]. In most cases, this implies a divergence from the independent work the academy traditionally performs. It is our job to promote such a collaboration. This is hard to operate in reality, however. One reason lies in a very tight schedule everyone faces, combined with long distances to be traversed. Daily operation dominates over design activities. The administration of a virtual university requires a reengineering as well, as has been reported in [Press 94] [Peters 94] and [Tames 96]. Whether teamwork can be achieved depends in these parameters as well.

4. Collaboratories at ITESM : Method

Our chances for a *synchronous cooperation* [Kouzes 96] are therefore null from a practical standpoint. We propose, as a possible solution, an *asynchronous, or Collaboratory cooperation scheme* [Kouzes 96]. The collaboratory solution implies a virtual laboratory that allows its users to access the tools, data and other resources they would normally use in a live session. In our case, such resources are determined by a *methodology for the design of educative software* within the context of the Virtual University project at ITESM.

The methodology is conceptual, but contained in practice within a Collaboratory that all participant professors and support staff are able to use. The technique consists on introducing diverse learning strategies as a particular Computer-Based Instruction (CBI) package is analyzed and designed. What strategy is used depends on the type of knowledge to be characterized. They are reported in [Morris 94]:

- Learning by doing.
- Expert Modelling.
- Situational Cognition (anchored Instruction).
- Induction.
- Drill & Practice.
- Deduction.
- Instruction Direct.

As can be observed, these practices contemplate a wide range of choices, previously defined as *Cognitive parameters*, and can be derived from both the Constructivist and the Instructivist paradigms. The reasons for choosing this particular set of strategies are :

1. Given the current institutional policies [ITESM 96], we must comply with a fixed set of academic requisites that structure our teaching work. These policies are mostly Instructivist.
2. We have concluded that a careful transition must be crafted when changing the "teaching-learning" paradigm to the "learning" one [Tames 96]. This is mainly due to the fact that our students have been trained under an Instructivist environment for many years.

5. Instructional Design Method

The methodology, taken from [Romiszowski 91] is now outlined :

1. Perform Goal specification.
2. Perform Task Analysis.
3. Perform Analysis of the Expected Audience.
4. Select an Instructional Strategy.
5. Design Content.
6. Perform Evaluation (ie. validation).

The model is analogous to the traditional Software Life Cycle as defined by the Software Engineering [Sommerville 92], and denotes the intersection of the following areas of knowledge :

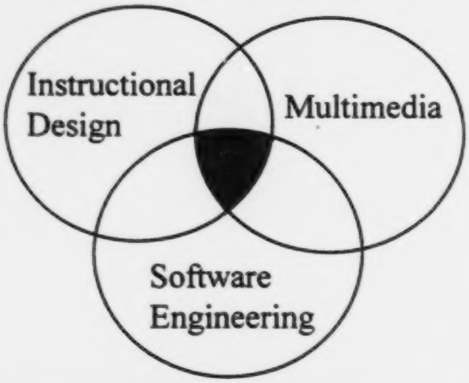

Figure 1: Multidisciplinary intersection

We now proceed to detail how a portion of this method can be ported to an Educational (and distributed) CASE tool we call a Collaboratory. The tool is derived, in part, from the EMI Model reported in [Espinosa 96b], and is being considered as a starting point for a future complete CASE tool that contains all the steps in the methodology. We actually use the method in a semi-automatic fashion in our project [Tames 96].

6. Implementation

Steps 2, 4 and 5 of the method outlined above are being reported as an implementation. We have developed a series of Web pages that function as a virtual notebook in which data is fed so that an Educational Flowchart (EF) is built. An EF is a hierarchical structure containing the models of topics and subtopics that make up a course. It specifies their direct and indirect relationships. From the standpoint of Information Systems, it is a Tree, or possibly a Graph, structure.

As the main structure of the EF is built, the nodes that compose it are filled out with data. Such data is defined from the pedagogical point of view, and is made up of *entities*. Each of these *entities* is analyzed and designed using an Object Oriented Software Engineering Methodology. We thus combine Information Systems with Pedagogy (refer to Figure 1). The justification for performing such an analysis and design relies on the fact that the resulting implementation project will be object oriented. We will deepen on this Object Oriented technique in section 10.

7. Instructivist Entities

We now proceed to formalize the method. Let *g* be the set of goals to be fullfilled by the educational software. Let *d* be the set of data items the professor has defined as educational elements to rely on. The Instructivist paradigm as defined before, consists on a series of predefined goals and objectives. We thus represent these sets in Figure 2 as fixed. We may therefore state that Instructivist entities are fixed.

8. Constructivist Entities

As before, let *g* be the set of goals to be fullfilled by the educational software. Let *d* be the set of data items the professor has defined as educational elements to rely on. The Constructivist paradigm as defined before, consists on a series of undefined goals and objectives. The data items are contained in a catalog-style container, and will be placed on sets in real-time. We thus represent these sets in Figure 3 as non-fixed. We may therefore state that Instructivist entities are non-fixed.

We wish to empasize that each goal may constitute one node of the EF previously described. As a consequence, the network of nodes depicts an educational relationship of goals & data.

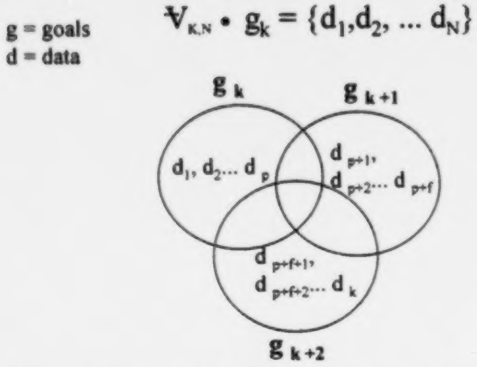
g = goals
d = data
$\forall_{K,N} \bullet g_k = \{d_1, d_2, \dots d_N\}$
g_k
g_{k+1}
g_{k+2}
$d_1, d_2 \dots d_p$
$d_{p+1}, d_{p+2} \dots d_{p+f}$
$d_{p+f+1}, d_{p+f+2} \dots d_k$

Figure 2: Instructivist method definition

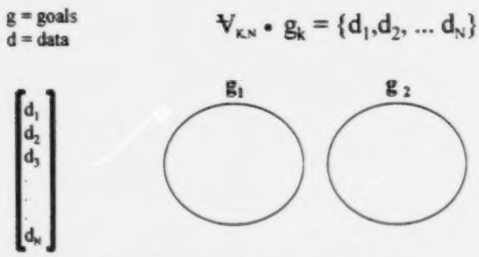
g = goals
d = data
$\forall_{K,N} \bullet g_k = \{d_1, d_2, \dots d_N\}$
d_1
d_2
d_3
d_N
g_1
g_2

Figure 3: Constructivist method definition

9. Entity Sequencing

In order for the designer to be able to define a sequence in which the entities are to appear, we provide yet another Software Engineering construct, called *Preconditions* and *Postconditions*. Namely, a *Precondition* is the set of requisites that must be fullfilled in order for an action (ie. entity) to execute. A *Postcondition*, on the other hand, is a set of requirements assumed to be valid after the action has been executed. Figure 4 adds Preconditions and Postconditions to our scheme. The use of these gadgets allows us to relate more than one entity to others. That is, we may reuse entities as needed. We will further explain this concept later on.

10. Object analysis & design of Entities

As said before, this prospective CASE tool will aid in the development of an object oriented web page. The entities are therefore defined in terms of a class hierarchy, as shown in Figure 5.

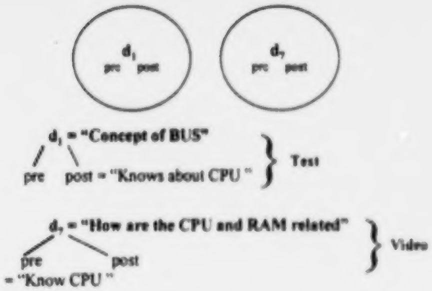
d_1
pre
post
d_7
pre
post
d_1 = "Concept of BUS"
pre
post = "Knows about CPU"
Test
d_7 = "How are the CPU and RAM related"
pre
post
= "Know CPU"
Video

Figure 4: Preconditions and Postconditions

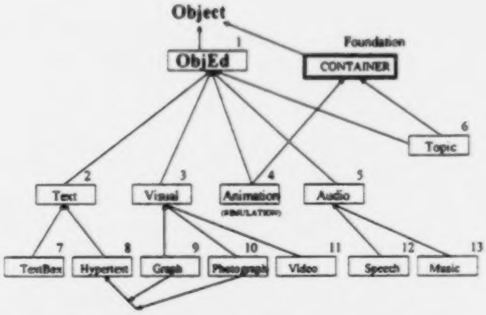
Object
1
ObjEd
Foundation
CONTAINER
6
Topic
2
Text
3
Visual
4
Animation
(SIMULATION)
5
Audio
7
TextBox
8
Hypertext
9
Graph
10
Photograph
11
Video
12
Speech
13
Music

Figure 5: Object Oriented Analysis/Design

All objects contain attributes. We specify these in Table 1. The attributes inherited by all objects are those listed in sections 7, 8 and 9 as the structural elements for the educational entities. Foundation classes are those standards which facilitate the implementation of a GUI or a base architecture.

Class	Attributes	Foundation
ObjEd	Strategy	no
	Media	no
	Precondition	no
	Postcondition	no
Text	Text	no
Visual	File	no
Animation	File	no
Audio	File	no
TextBox	(none)	no
Hypertext	Link	no
Graph	(none)	no
Photo	(none)	no
Video	Duration	no
Speech	Duration	no
Music	Duration	no
Container	(predefined)	yes

Table 1: Class Hierarchy and Attributes

Finally, we provide an example of a design created and modified in a collaborative fashion : a

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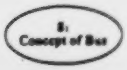

S1
Concept of Bus

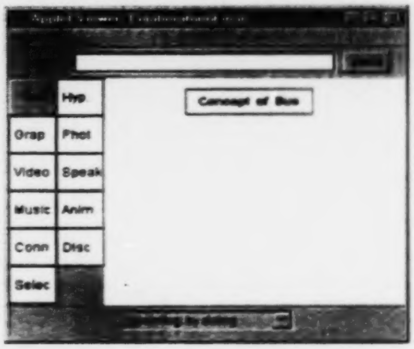
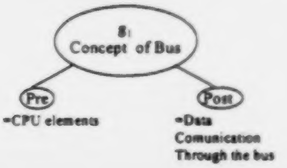

Applet Viewer: ColaborationalFinal
Hyp.
Grap
Phot
Video
Speak
Music
Anim
Conn
Disc
Selec
Concept of Bus

Figure 6: Step 1 of the design

CS[1] course, where the concepts of CPU and data bus are introduced.

The first step (see Figure 6) is to specify the main topic (Concept of Bus) using a Text object. The second step is to establish the preconditions and postconditions required for this topic (Figure 7).


S1
Concept of Bus
Pre
Post
=CPU elements
=Data Comunication Through the bus

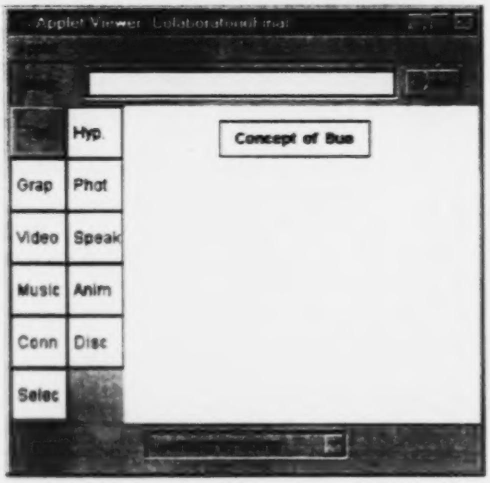
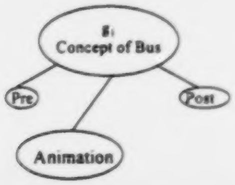

Applet Viewer: ColaborationalFinal
Hyp.
Grap
Phot
Video
Speak
Music
Anim
Conn
Disc
Selec
Concept of Bus

Figure 7: Step 2 of the design

The third step is to define a pedagogical strategy (from the list in section 4). See Figure 8.

At this point, the user interface aids the user with respect to the strategy just selected. The system will not provide any further (ie. intelligent) help.

At a later (ie, asynchronous) time, the current design, stored in the WWW, will be examined by some other member(s) of the team, and feedback will be emitted. This is shown in Figure 9, as the changed are reported by this other user.


S1
Concept of Bus
Pre
Post
Animation

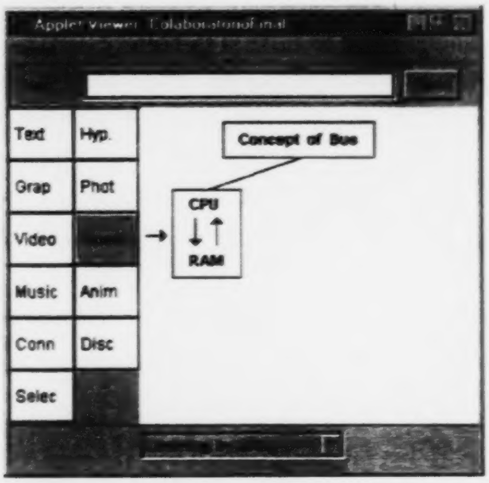
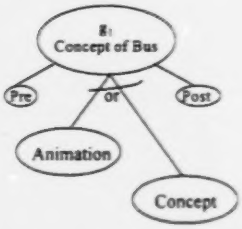

Applet Viewer: ColaborationalFinal
Text
Hyp.
Grap
Phot
Video
Music
Anim
Conn
Disc
Selec
Concept of Bus
CPU
RAM

Figure 8: Step 3 of the design


S1
Concept of Bus
Pre
or
Post
Animation
Concept

Finally, someone may propose two other strategies aimed at understanding what a Bus is. These need not be complementary (ie. reinforcing one another). There may be other ways in which a student may learn. The original model is thus enriched with the participation of several experts. See Figure 10.

---

[1] Introductory Computer Science

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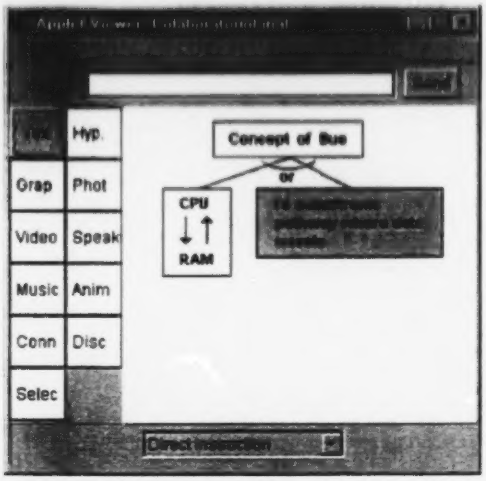
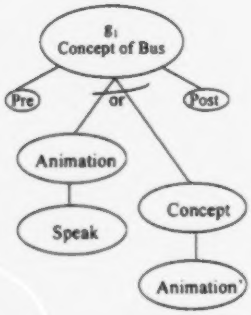

Hyp.
Grap
Phot
Video
Speak
Music
Anim
Conn
Disc
Selec
Concept of Bus
or
CPU
RAM
Direct instruction

Figure 9: Step 4 (collaborative)


S_1
Concept of Bus
Pre
or
Post
Animation
Speak
Concept
Animation

The reader may already have noticed that the graph (or tree) representation of the educational design (EF) is updated to the right of the detailed model. This is the operational scheme used by our Web Page. Condensed results (ie. statistics) are presented to the user in the form of reports and summaries, which allow the quick view of data which is not usually understandable to all types of users.

11. Experimentation

As cited in [Kouzes 96], the software is to be socially accepted for it to trascend. We will be conducting a series of important experiments. These are crucial if we are to obtain a stable and long lasting product. This software is designed based on educational criteria, and validated as reported in [Espinosa 96a] and [Tames 96]. The implementation is written in Java, and makes heavy use of database access and remote message passing.

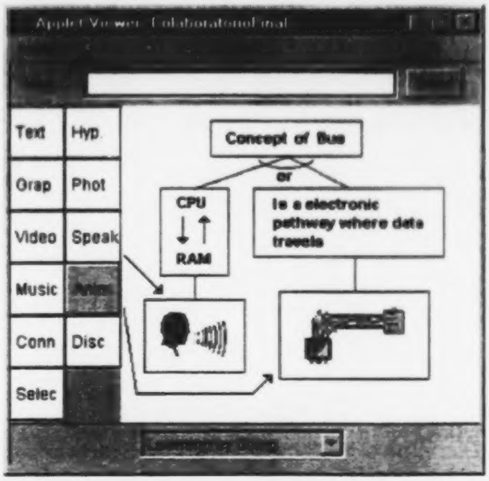

Text
Hyp.
Grap
Phot
Video
Speak
Music
Anim
Conn
Disc
Selec
Concept of Bus
or
CPU
RAM
Is a electronic pathway where data travels

Figure 10: Final Design (collaborative)

12. Conclusions

We have obtained an initial method for the development of educational software by integrating instructional design, multimedia and Software Engineering, based on an educational background that resembles our institutional needs as closely as possible. We want to emphasize how important it is to bring together a team with these multidisciplinary characteristics. As we maintain this line of research, we will [eventually] achieve a definition of what bringing a course to a virtual state really means.

For more information on this project, please visit us at *http://www.ccm.itesm.mx/~uvirt/uvirtual.htm*

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Strategies for Developing Cost-Effective And Powerful Interactive Multimedia Educational Materials

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Abstract: Interactive multimedia (IMM) will only become a mainstream educational method if IMM titles:

- result in excellent educational outcomes (at least better than other methods); and
- can be developed within reasonable resource constraints.

Without achieving both of goals, IMM will be relegated to the margins of educational materials development and even brilliant projects will burn brightly for a short time before sinking below the surface without a trace. This paper examines some strategies we are using at the University of Southern Queensland to develop affordable and powerful IMM and web delivered learning environments.

Impetus and Barriers for Multimedia Development

Most universities and other education and training providers are increasingly using flexible delivery and interactive multimedia (IMM) technologies (digital tools used to represent, process and transmit textual, graphic, audio and video information). Increased use is due to the changing nature of students and a need to provide educational products marketable to a range of people at a time, place and pace defined by the user.

However, IMM materials require longer and more complex developmental processes involving many different groups of people working together. Also, if IMM systems are qualitatively different to traditional educational media (paper, video, audio) then academics must totally rethink the educational process. Ironically the speed of technology development can also be a barrier to the development of IMM. For example, the **technoluster** who is forever, trying beta releases and has a hard disk full of software which is not actually used for any **real** task. In a world of almost unlimited possibilities enabled by technology, it is important to carefully identify what we want to do and then work towards achieving this.

While these problems apply in all contexts some occur more often in universities. "Paralysis through analysis" often afflicts academics who endlessly debate the "perfect" way of doing something and end up doing nothing. Academics are also notoriously loathe to use a resource which they themselves have not developed.

Strategies for Affordable IMM Development and Use

The remainder of this paper examine strategies to decrease the development and delivery cost of powerful IMM titles. Some strategies may be implemented at the institutional level, while others are more applicable at the levels of the IMM development group or the individual project team. This paper does not attempt to quantify, in absolute terms, development and delivery costs. Many of the strategies discussed in this paper are based on the ratio between development time and the time the package is used. Thus, either increasing the number of users, the time the package is used, or spreading developmental overheads over a number of projects will result in lower per unit developmental costs.

Focus on Core Objectives

IMM technologies are impacting on all university activities—teaching and learning, research, administration and community service. Within teaching and learning, IMM may be used in several different ways emphasising different aspects of the teaching-learning episode and different educational models, e.g.:

- Computer Assisted Learning (CAL) focusing on presentation of carefully structured teaching sequences;
- Computer Managed Learning (CML) focusing on assessing learning and managing access to materials;
- Computer Mediated Communication (CMC) focusing on interactions between people;
- Interactive Multimedia learning resources focusing on finger tip access to educational resources.

While, features of these applications are converging it is critical that IMM development groups focus on one or two styles in order to develop affordable products. At USQ we are focusing on the development of IMM learning resources for several reasons. IMM learning resources may be used in a number of units and are generally used for significant amounts of time compared to traditional CAL materials. The flexible structure of IMM learning resources also allows the inclusion of CAL, CML and CMC facets when appropriate to the needs of the users, the tasks at hand and the features of the content.

A further advantage of focusing on IMM learning resources is that it allows us to capitalise on the vast amounts of print based information which most universities already own. I am not suggesting that existing paper based content be simply reformatted for screen presentation (shovelware), but rather that this information should be integrated into the IMM environment in a way which adds value for the user. For example, a current USQ project involves a CD-ROM based database of images and animations. While the majority of students will read the text of the unit on paper, this text will be also included on the CD-ROM, allowing the student to more easily find, understand and use the media resources.

Theories from psychology, education, information science and human-computer interaction can also be used to focus the implementation of individual projects. Without such guidelines it is difficult to focus on clear goals and the plethora of possibilities offered by IMM is one way of overspending development budgets. One such principle is that the IMM environments should reduce the cost for a person to find, understand and use a piece of information, as well as increase the value of that information. However, the value of an IMM environment depends on a complex set of interactions between the features of the content, the users, the tasks they are set, and the tools that are provided [Evans 93].

Collaborative Work Between People and Groups

IMM development requires co-operative input from people with different expertise (content, video, graphic, textual, programming, project management, legal etc) and from different departments. If a university is to develop useful IMM, then it is necessary to foster a strong coalition between these different groups. Strategies which offer individuals and groups opportunities to best utilise their strengths and participate in a "win-win" collaborative effort, are more likely to be effective then "brute force" strategies (e.g. restructuring).

Within USQ both top-down and bottom-up strategies are used to foster cross-sector collaborative groups. The Flexible Delivery Committee [USQ 95] consisting primarily of Deans and the Deputy VC sets policy and broad parameters for the direction and pace of the use of Flexible Delivery technologies. The "multimedia@USQ" [Multimedia 96] user group supports practitioners who are using IMM and provides a forum to showcase their work, and share experiences and expertise. Collaborative work is also fostered at the level of the unit team which at USQ consists of content experts, an instructional designer and if required an IMM developer.

Strategic Planning and Staged Development

Deployment of IMM educational materials requires faculties and the university as a whole to set long term plans if costly mistakes and delays are to be avoided. Long lead-times are also necessary to ensure that the infrastructure is available for the IMM to be effectively delivered to students. Many faculties within USQ are currently moving towards requiring students to have access to a certain level of computer at a specified time in the future. This means that core educational materials may be distributed electronically without the added cost of a dual development and delivery system. In return for their investment in computers, students will be assured that they will use the computer in the majority of units over the duration of their course. Each USQ faculty has prepared a rolling 3 year plan for the introduction of flexible delivery technologies.

Deliverable Products vs. Ongoing Expertise and Infrastructure

Another way of reducing developmental costs is to ensure that each IMM project is conceptualised as both a deliverable product **and** also as an opportunity to develop infrastructure, expertise and models which will be used in future projects. The mix between these aspects is different for each project and it is important not to overly force the aspirations of individual projects into the "grand plan" for the group. While most projects broadly support this developmental principle, each is periodically examined to ensure that it is contributing to the expertise and skills of the group. The "retained" part of each project may take several forms.

Content structuring and markup: A major asset of any university is the intellectual property of its staff and its expression in teaching materials. While paper based content will be used into the future, it is clear that this content should be organised allowing it to be moved from one presentation format to another-"author once--play anywhere". For example, the one source document could be used as the basis for documents distributed on paper, CD-ROM or perhaps the WWW. Markup languages such as SGML are becoming increasingly common ways of "future proofing" content.

Functional tools and interfaces: Projects in different faculties will emphasise different tool sets and different representational media e.g., calculators and scientific simulations would be more common in a unit taught in the Faculty of Engineering and Surveying than an Art or Education unit. However, there is also a core of functionality and media types which are consistent across all disciplines. For example, all IMM learning resources should allow the user to follow thematic links between information. It is imperative from a cost effectiveness point of view to ensure that the tools used to create these links, the underlying data structures, and the way in which students use them are developed once to avoid "reinventing the wheel". Tools such as context sensitive online help, word search and indexes should also be reusable in a variety of titles. A complete functional specification of the Hathaway CD-ROM can be found in Hathaway [Evans 96].

Underlying code: While true cross-platform development and delivery is still problematic, developmental costs can be reduced significantly by implementing functionality in ways that are robust, generalisable and maintainable. The code should also be written in a way which isolates key functionality from the underlying hardware and software. For example, tools are being produced that facilitate translation of content between systems such as HyperCard, SuperCard, TookBook and Director.

Project Management

IMM projects, like other projects involving many people, benefit from close project management in which roles, responsibilities, and demonstrable mile-stones are clearly specified. This does not mean that all members must attend long minutely minuted meetings. Generally project goals are not achieved in meetings—the meeting establishes the potential to achieve goals but the goals are achieved through work in between the meetings. We have found it useful to have short weekly meetings after which actions and decisions are minuted and attached to a single name for action.

Development Processes

Software Platforms

Numerous authoring systems claim to increase the productivity of multimedia programmers--some even claim to replace the programmer. All environments have strengths and weaknesses and this paper is not the place for a platform war in favour of a particular environment. However, it is important to carefully match the skills of the programmer with the design specification of the project and the features of the tools which are used. For example, the Hathaway CD-ROM was developed using a general purpose scripting language because it allowed us the freedom to create the tools which were required.

Development Tools

The development of the Hathaway CD-ROM involved creating numerous tools which will be used in future projects. For example, link creation involves selecting the start anchor (a phrase of text, a visible button or a region) and then selecting the end anchor. The link is then automatically created, stored in the link database and the anchors visually highlighted. Once created links can be verified, sorted, or processed using other tools.

Hand-coded "button" Multimedia vs "tool" Multimedia

Some multimedia products are entirely hand-coded and all functionality has been created on a "one-off" basis. Often these products are created by content experts who have recently been visited by someone selling the "ultimate" authoring tool. This process is not only very labour intensive during its creation but also almost impossible to maintain. This is a common reason why initial breathless enthusiasm is often replaced by the sobering realisation of the limits on the depth or amount of information many IMM environments contain.

In contrast, the goal of the developer should be to create IMM titles which provide tools for both the developer and the end-user. For example, attaching several index terms to each node and providing a flexible way to navigate these index terms provides the user with an opportunity to investigate thematic issues which might not have been considered by the developer. Moreover, the value of these index terms increases with the number of nodes rather than collapsing under their own weight as they may do in a hand crafted system.

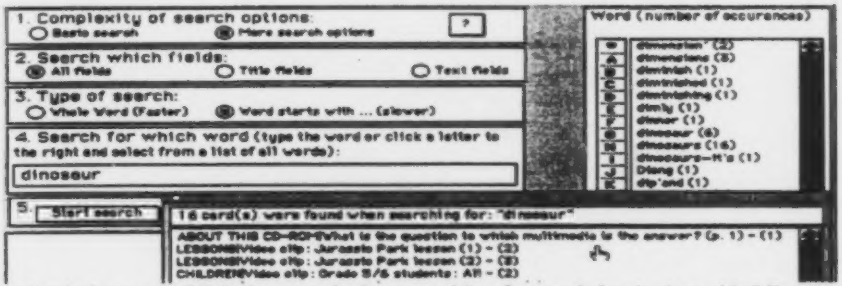
Rapid Prototyping

Some models break the software development process into a sequence of steps such as requirements analysis, specification, implementation and testing. In my experience such models have not been very useful in IMM development, partially because people and the project are in a continual state of evolution and development. A more useful approach has been rapid prototyping in which a prototype (either a sketch on paper or a computer implementation) of a small part of the project is constructed and then placed "on the table" for examination by the project group.

Tools for the User

The Hathaway CD-ROM contains tools to help the user to navigate, find information, understand information, and use information. These are general purpose tools which have been used in subsequent projects.

Tools for Finding Information



1. Complexity of search options:
○ Basic search ● More search options

2. Search which fields:
● All fields ○ Title fields ○ Text fields

3. Type of search:
○ Whole Word (Faster) ● Word starts with ... (slower)

4. Search for which word (type the word or click a letter to the right and select from a list of all words):
dinosaur

Word (number of occurences)
dimension' (2)
dimensions (8)
diminish (1)
diminished (1)
diminishing (1)
dimly (1)
dinner (1)
dinosaur (6)
dinosaurs (16)
dinosaurs—it's (1)
Diang (1)
dip'and (1)

16 card(s) were found when searching for: "dinosaur"
ABOUT THIS CD-ROM\What is the question to which multimedia is the answer? (p. 1) - (1)
LESSONS\Video clip: Jurassic Park lesson (1) - (2)
LESSONS\Video clip: Jurassic Park lesson (2) - (8)
CHILDREN\Video clip: Grade 5/6 students: All - (2)

Figure 1: Search window and of "hits" returned when searching for words beginning with "dinosaur".

Broadly speaking electronic environments provide two different styles of tools for people to find information—query based searching and browsing. The Hathaway CD-ROM provides both methods and allows the user to select the one that is most relevant to them and the task at hand. Figure 1 shows the "Query based Word search" window [Fig. 1] allowing the user either to enter a search term or select it from a list and which returns a list of all nodes containing that term. While indexing the database is very slow (over 8 hours on a mid range PowerPC

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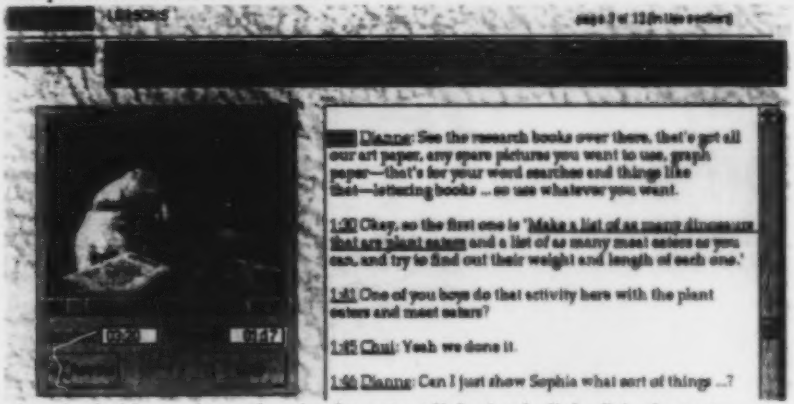
based machine) retrieval is very fast (less than 10 seconds for most searches). The effort involved in writing this indexing and retrieval tool is justified through multiple reuse.

Tools for Recognising and Understanding Information

Once information is displayed, the user has to understand it and recognise its relevance before it can be used. Electronic environments can provide many tools for helping the user to understand information including:

- using multiple interlinked representations of information;
- highlighting relevant parts of the data;
- providing links to related information; and
- providing interpretations of the information.



Dianne: See the research books over there, that's got all our art paper, any spare pictures you want to use, graph paper—that's for your word searches and things like that—lettering books ... so use whatever you want.

1:30 Okay, so the first one is 'Make a list of as many dinosaurs that are plant eaters and a list of as many meat eaters as you can, and try to find out their weight and length of each one.'

1:41 One of you boys do that activity here with the plant eaters and meat eaters?

1:45 Chui: Yeah we done it.

1:46 Dianne: Can I just show Sophia what sort of things ...?

Figure 2: Synchronised video and text showing hypertext links (underlinked) in the text.

The Hathaway CD-ROM provides all of these tools and presents information using a range of interlinked symbol systems (text, images, video and sound). For example, the video based interviews are linked to a synchronised text transcript. The synchronised nature of the text and video means that students can browse through either to find the corresponding part of the other. Additionally it means that we were able to use tools traditionally applied to text to also work with video and other time based media (e.g. animations moving around a school building). For example, we can create hypertext links between specific segments of video or use word search to search for any video were a particular person is speaking. Figure 2 shows a segment of video of a lesson where the teacher is guiding a student through a worksheet. Links in the text allow the user to synchronise the video [Fig. 2], see glossary entries for the speakers or follow hypertext links (clicking on "Make a list ..." displays a scanned image of the worksheet on the desk) to related information.

Because we have developed general tools to enable this synchronisation of text and time based media to be easily created we are able implement this at numerous places in the package at little cost.

Tools for Collecting, Using and Understanding information

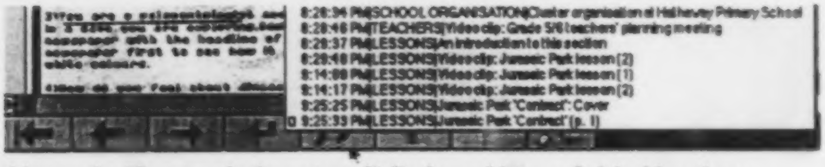

8:20:34 PM|SCHOOL ORGANISATION|Cluster organisation at Hathaway Primary School
8:20:46 PM|TEACHERS|Video clip: Grade 5/6 teachers' planning meeting
8:20:37 PM|LESSONS|An introduction to this section
8:20:40 PM|LESSONS|Video clip: Jurassic Park lesson (2)
9:14:00 PM|LESSONS|Video clip: Jurassic Park lesson (1)
9:14:17 PM|LESSONS|Video clip: Jurassic Park lesson (2)
9:25:25 PM|LESSONS|Jurassic Park 'Contract': Cover
9:25:33 PM|LESSONS|Jurassic Park 'Contract' (p. 1)

Figure 3: Clicking on the "footsteps in the wet sand" displays a history of visited locations.

If hypermedia technologies are powerful tools for presenting and organising information then **end-users as well as developers** must have access to tools that enable them to use, link, and organise relevant information. General purpose tools for collecting information in the Hathaway CD-ROM include automatic histories, annotated

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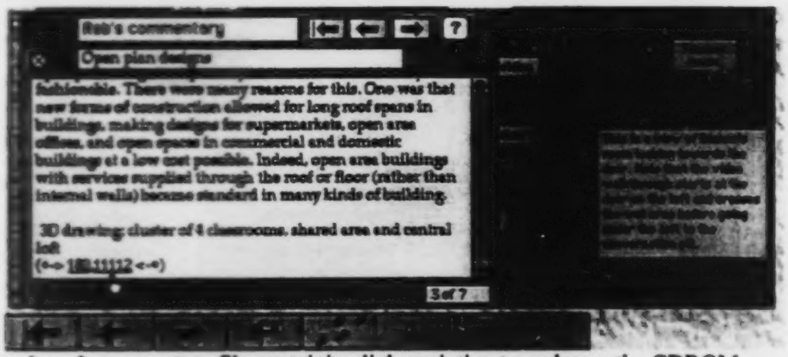
bookmarks, and research notes. Figure 3 shows a list of nodes which have been visited in the current session allowing the user to return to a recent location by selecting it from the pop-up menu [Fig. 3].

Users of the Hathaway CD-ROM can create links and record notes in commentary file stored on their own floppy or hard disk. Figure 4 shows such a commentary file and commentaries will also be used to submit assignments either via floppy disk or email [Fig. 4]. When an embedded link (shown as the underlined number) is clicked the appropriate part of the case record is displayed and the students interpretations could be verified by looking at the surrounding information.



fashionable. There were many reasons for this. One was that new forms of construction allowed for long roof spans in buildings, making designs for supermarkets, open area offices, and open spaces in commercial and domestic buildings at a low cost possible. Indeed, open area buildings with services supplied through the roof or floor (rather than internal walls) became standard in many kinds of building.

3D drawing: cluster of 4 classrooms, shared area and central loft
(<-> 10.11112 <->)

Figure 4: Floppy based commentary file containing links pointing to nodes on the CDROM.

Summary

While the power of a multimedia title it not necessarily directly proportional to the cost of its development, the process of multimedia development is a continual process of balancing cost and power. If products are not powerful and thus don't justify their existence, then the use of IMM for university teaching and research will be significantly slowed. On the other hand, even the most brilliant IMM project will not be successful in the longer term if it can't be developed within a reasonable budget.

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Asynchronicity: Distributed Learning Communities

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Abstract: This paper explores the new roles of learners and universities as we, or others, shift from teacher-centered instructional formats to learner-centered instructional formats. The first section, entitled *Historic View*, describes how much of what is done in universities qualifies as an asynchronous model of education and how this shift to asynchrony could be more complete and deliberate. The second section, *Future View*, describes how universities may change their orientation to the methods of instruction away from teacher-centered formats to learner-centered formats. The final section, *CyberStoa*™ offers a criterion for judging technologies' optimum role in fostering distributed learning communities. This paper offers a set of reflections and starting points on which to analyze our initial efforts at shifting toward asynchronous learning networks as a more prominent mode of Higher Education.

Historic View

Traditionally, college and university faculty and students have convened in classrooms for the expressed purpose of teaching and learning. This scenario is so prevalent and assumed that stating it sounds like hyperbole. We all know what Higher Education looks like; a professoriate lectures to a large mass of attentive studentia. We also know that the profesoriate and the studentia are brought together into the same large lecture halls under the guise of learning. However, deep within this scenario several expectations and assumptions exist. Several of these assumptions, when closely examined are if not obviously false at least questionable.

Traditional views of teaching allow teachers several active roles: lecturing, offering explanations, describing lab activities, setting out exercises, guiding practice sessions, conducting evaluation and assessment, guiding critical discussions as well as many others. Traditional views of learning offers learners relatively few roles, most of which are passive: listening, note taking, following instructions, practicing skills, or performing memory tasks during evaluation. Over the last few years research in the cognitive sciences [Kandel & Hawkins 1992], [Fishback 1992] and empirical observation of learning situations [Nunn 1996], [Goodlad 1995], and [Cuban 1986] has lead educators to conclude that these predominantly passive roles of learners have, in fact, inhibited learning or relegated it to occurring during out-of-class time.

Reading about topics heard in lecture, practicing skills described or demonstrated, discussion with other learners, writing up reports, analysis of data are all typical tasks and activities that students have completed in order to learn. Often these are done out of class. There is nothing unusual about this or the expectation that much of a course's cognitive activities happen out of the classroom. This is important for several reasons; two are worth describing in detail.

First, this opportunity or expectation, for learners to process, practice, discuss, read, write, diagram, hum , dance, plot, diagram, investigate or classify allows them the freedom to explore the intellectual demands of the specific learning situation in manners comfortable or efficient to the learner. Whether one subscribes to Gardner's Multiple Intelligences, [Gardner 1993] or learning styles, or to a culture-specific/background-specific orientation to learning in its various forms, it is a rare individual or theory that allows for only one single path to learning. This traditional asynchronicity, the expectation that students will on their own time work through course material in their own ways, has allowed, but not fostered multiple orientations or paths to learning.

Second, this opportunity or expectation, allows learners to gain contrast, alternate sources, explore concepts in new ways, in a location amenable to the learner. While students are tied to campuses where lectures or specialized laboratory equipment is located, they are expected to learn beyond the lecture hall or laboratory. At home in soft light, at work while doing labor, while driving, while exercising, at night in dreams, good learning takes place; learners are not expected to do all of their learning in the classroom. This traditional asynchronicity and the expectation, that students will learn in setting of their own choice, has allowed limited geographic dispersion of learners due to the ties of the lecture hall.

With this historic description of education it is clear that many educators facilitate asynchronous learning. There are other ways that learning is asynchronous. In any classroom of learners there are many different paces, patterns and paths to learning any subject or skill. Within these individual learners there are also a limited number of "sublearnings" that can happen in many different orders. Generally, the class is in the same realm on the syllabus and many learnings have precedent and antecedent sublearnings, but to a large extent, learning is clearly a process that in not tightly synchronized to teaching. Therefore, building on traditional views of learning and education, describing what asynchronous learning is and what its benefits are should not be difficult. However, proving it efficacious, might be difficult if not impossible, based on the complexities and difficulties associated with educational research.

So far, we have explored and might agree that . . .
- In traditional classrooms, learning is not synchronized with teaching.
- In a group of learners, learning is asynchronous.
- In any individual there are many asynchronous elements to learning.

Future View

For the purposes of this discussion the designation "asynchronous learning" implies that the acts of learning and the acts of teaching are not simultaneous or colocal. Here I describe in two steps, what shifts toward asynchronous learning might look like (Desynchronization) and then how the shift might be coordinated (Coordinating Desynchronization) and assessed.

Desynchronization. Aside from the above described asynchronous learning activities, adding just a few new elements liberates, but does not exclude learners, from the colocal expectations of lectures and in some cases, laboratory experiences. The elements of asynchronous learning are not aimed at separating students from instructional aid or from each other, in fact quite the opposite is true. There are several types of activity that are predicated on groups of students interacting (group discussions, team mastery of skills, . . .) and student/teacher interaction (remediation, feedback, mentoring . . .).

Decreasing the dependence of instruction on lecture and shifting to asynchronous techniques could take several forms, ranging from simple and elementary to advanced and complex; these are just a few quick examples:
- replacing lectures with video taped presentations, or with Internet based multimedia presentations, thus allowing participants to view presentations multiply, at their pace, and at their personally optimum times,

- replacing the administrative elements of classtime (passing out papers, handling attendance, addressing questions personally, . . .) with Internet based document distribution or asynchronous bulletin board question-and-answer postings,
- replacing limited laboratory experiences with Internet based interactive multimedia environments capturing the elements of these learning scenarios with the added convenience of Internet transportability and speed and ease of data collection,
- implementing coordinated, credited and endorsed small group meetings for discussions that can not be moderated well in large lecture formats,
- implementing coordinated, credited and endorsed work sessions connected with specific skill or task outcomes, and
- implementing coordinated, credited and endorsed peer-mentoring, peer-tutoring and peer-coaching strategies are just a few of the ideas about how to convert from teacher centered instruction to learner centered instruction.

This list is incomplete and limited only by imagination. Good educators are likely to be able to produce many more methods for enhancing learning environments that, not just make possible, but endorse and credit specific types of asynchronous learner-centered learning activities. This list is designed to be illustrative of the shift to asynchronous learning environments. The last three examples emphasize the importance of peer and student/instructor communications networks. As this shift to asynchronous techniques occurs a concordant shift in assessment strategies may also take place.

This shift towards asynchrony should be evidenced by changes in assessment and evaluation strategies from the standard single-purpose model to the individual purpose model. If this learning is conducted by multiple paths and for multiple purposes, the assessment should reflect this. This shift should be evidenced by more "authentic" assessment and by more social opportunities for understanding the results as feedback in more formative settings. As the shift from summative to formative assessments occurs, the tendency to view outcomes as fixed, rather than negotiated, will tend to disappear, and learning paths will converge on success rather than be truncated at the termination of the contracted course engagement. As these trends occur, or to the extent that they do not occur, there are organizational opportunities and impacts possible.

Coordinating Desynchronization. The organized institutional efforts aimed at incorporating faculty's use of asynchronous learning networks are directed toward shifting the culture form a Teaching Paradigm change to a Learning Paradigm [Barr & Tagg, 1995]. Barr and Tagg (1995, p 18) cite Peter Senge's *The Fifth Discipline* [Senge 1990], in support of organizational changes to reflect the shift in values. To Barr and Tagg (and Senge), changes to the organization supporting the learning paradigm are as important as the decision or desire to shift towards the learning paradigm. In other words, a good metric of the university's efforts to shift its commitment towards learner centered instruction would be a description of its organizational change or development. In a generic way this means that organizations committed to shifting toward asynchronous learning networks will have new organizational features addressing these aims, or old organizational elements will be repurposed toward these new goals. In organizations that have no detectable organizational adjustments, will despite their rhetoric, have no real shift in effort toward the learner centered goals of asynchronous learning. A simple set of coordinated organizational activities targeted toward technological facility and social support, should occurr by or focus on asynchronous learning networks as the common vehicle for organizational change and student instruction. Universities sensitive to preparing students to be self-directed collaborative learners will undoubtedly focus on asynchronous learning networks as a key element of their student preparation and their oprganizations will cahnge in relation to their committment. If not other credentialing agencies will arise to fill a consumer desire to credit learning experiences outside of classrooms, which in all probability will utilize asynchronous learning networks. Several university scholars have explored this issue [Langenberg 1966] , [Casper 1995], and [Wulf 1995] and many agree that these forces will impact higher education and that one of their probable modes of operations will indeed be distributed asynchronous learning networks.

CyberStoa™

As the technology plays a larger and larger role in uniting students with learning experiences, technologies' role becomes more and more critical. Mechanical features of reception, speed, ease, manageability, intimacy and a host of other hygiene factors will be very important to the success of learners in distributed telecomputing-dependent learning situations. Organizations that attend these issues in both design and delivery phases will emerge as the quality leaders in this field. Institutions expecting high throughputs, yet with low quality may not be able to stay in business in an arena where the competitors are global and absolutely no geographic barriers exist for course delivery and participation. In instances where there is less and less institutional affiliation such as brand recognition or attending universities of popular football teams, the educational and technological environments will be more direct issues in choosing educational settings. Attendance will no longer be based on tradition and extracurriculars, the institutional quality may become to be solely judged by the technological faces and interfaces for learning.

So what criterion would be optimal in terms of evaluating the technological aspects of organizations and their delivery mechanisms? I offer one: transparency. Transparency that translates into ease of use, lack of distracters, clarity of purpose and function, minimized administrivia, simplicity in operation all will be features of successful technological environments for learning. In the same way that learning works best in well light, quiet rooms, with little cognitive distraction, the technological environments that allow us to interact in clean, efficient, unencumbered fashions will be both preferred and more successful.

Currently there are several asynchronous tools for communication, simulation and interaction with a variety of multimedia. Successful systems will have the standard benchmarks of transparent utility and function that devices such as the telephone and the water fountain have. Without directions is their use transparent? Does the medium disappear? Is the experience of extracting the message or the water more distracting than necessary? Is the placement central to purposes? Do the uses match the purposes? Or are placement and uses contrived? This simple benchmark seems to support most of the critical use issues associated with technology. Negroponte (1995) describes the interface as one of the most important issues in computing and technology and describes the best interface solutions as "intuitive." Without delving into common experience and intuition, the touchstone of transparency seems to fit as a useful criterion of technology placement and use.

Test this criterion on your use of other technologies. Does the programming of your VCR obscure your viewing movies? Does adjusting the various settings in your automobile preoccupy you and distract you from driving? Does your computer interfere with your work? With these types of comparisons and judgments, then apply this criterion to a hypothetical learning situation; does the delivery mechanism interfere with your learning? Does the involvement in groupwork in a distributed setting hamper your learning? Does the dialogue established between students flow, unimpeded by technology? Are the channels of delivery unencumbered by bandwidth, velocity, or needless user protocols? At times when data flow velocity is critical are the chosen modes capable? The use of the transparency criterion can be summarized: As a learner is your primary experience in a technologically assisted asynchronous learning network involved with learning or with technology?

Consider the stoas in ancient Greece. These were little more than covered pavilions or walkways. They were halls in which scholars could roam and discuss issues and ideas. They were open to the air and the public, and they had no walls. Imagine these elements of structure applied to technology. Does it pose barriers? Does it close off or partition learning into boxes and rooms? Asynchronous learning in technologically supported distributed communities would resemble CyberStoa™ in their ease of use, openness and simplicity. This simplicity and ease of use are targets of successful VWSU activities.

Conclusion

This paper briefly described the elements of asynchronous learning which often already exist on the university campus and then proceeds to describe ways that the asynchronous environments will benefit students and future universities. This paper describes methods and systems which foster the shift toward asynchronous learning networks and their evaluation. Shifts in the functions and roles of technology were explored by describing the successful criterion of transparency and an idealized model: the CyberStoa™. To the extent that these are testable hypotheses, the conditions and expectations described within, could be the basis for research into the efficacy of telecomputing in asynchronous learning networks.

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IPERtool: an Authoring Visual Environment oriented to the Development of Educational Hypermedia Applications

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Abstract: Starting from the statement that hypermedia systems are useful tools for supporting educational communication between teachers and students, in this paper we examine the requirements of an ideal hypermedia authoring tool oriented to the development of didactic products. Ease of use, production of material that is usable both in a local and in a distributed environment, compatibility with other hypertext formats and automatic, secure and reliable publishing of information are identified as the key characteristics for this purpose. After that IPERtool, a visual environment for hypertext authoring developed at Politecnico di Torino, and especially though for helping teachers with no computer science background in producing their didactic material is introduced with respect to the identified requirements. We list and comment the main characteristics of IPERtool from the author's and the user's points of view, give a technical description of the tool and finally consider a number of applications that we developed at Politecnico di Torino using IPERtool as the authoring tool.

1 Introduction

We, like other researchers in the educational field [Conklin 87] [Nielsen 90], consider hypermedia as useful tools for teaching and learning [Farinetti & Scarafiotti 1995a] [Farinetti & Scarafiotti 1995b] [Farinetti & Scarafiotti 1996]; the hypertext structure combined with the characteristics of multimedia presentation offers an emotional impact on the students, the potentiality of grabbing their attention, the redundancy of the communicated information that can strike simultaneously different sensorial inputs, and an organization of the concepts which resembles the process of knowledge building.

A teacher, then, can become the author of an hypermedia tool, that will support him in the traditional communication inside the classroom or will substitute him in case of distance learning scenarios. The motivation of the teacher in experiment this new didactic strategy is usually strong, but his unhappiness in dealing with the practical problems of the implementation can be even stronger; today the number of available commercial tools for hypertext authoring is very large, and the author usually have to choose whether to distribute the product on a telecommunication network (Internet) or to use a local support (CD-ROM).

The growing popularity of hypertexts is strictly related the increasing accessibility of the authoring process: HTML, the language for Internet publishing, is a simple language, and non-experts in computer science can learn it and produce their own pages with little effort. In many cases, however, teachers feel that this way of authoring is a waste of their time, and think that the process of writing tags and checking the result with a WWW browser (Netscape, Mosaic, Microsoft Explorer, ...) is annoying. Often the implementation process is then committed to an assistant that could have a weaker pedagogical skill, and the communication between the two authors becomes difficult and time-consuming. Some teachers, in addition, would appreciate the opportunity of having a way of distributing the same hypertext both on Internet and on a local support without having to reorganize and reprocess the material [Brown 1994].

Another feature for helping the teacher would be the possibility of importing didactic material written in a different format (document, text, Windows Help hypertext, ...) without much effort, and to export the resulting product in a different format.

The ideal authoring tool, then, should meet all these requirements, but should also have a very simple, easy to learn, easy to use interface, possibly a visual one that operates according to a WYSIWYG (What You See Is What You Get) philosophy. This is what we had in mind (i.e. our "model" of a potential teacher-author) when we designed and implemented IPERtool, a WYSIWYG environment for hypertext authoring developed at Politecnico di Torino.

IPERtool has been designed especially for teachers with no particular programming skill, and its aim is to give them a complete visual environment for writing their hypertexts and publish them both in Internet and in a MSWindows environment. The idea of designing IPERtool grew from a much less challenging need: the problem of translating an already existing hypertext written for the Windows Help into an HTML one. Since the available automatic translators were not satisfying, and since we did not want to translate it manually, we started to define the requirements of an authoring tool for writing and browsing hypertext which were completely compatible with HTML and which permit the translation among the most used hypertext formats.

In section 2 we will examine the main characteristics of IPERtool from the author's and the user's points of view, while in section 3 a technical description of the tool will be given; section 4, finally, will describe a number of applications that we developed at Politecnico di Torino using IPERtool as the authoring tool.

2 The author, the student and IPERtool

Our aim was to simplify the "relationship" between a teacher-author and his authoring tool, and to guarantee a large distribution of the educational product once it is finished; we defined a number of requirements for reaching these goals:

- authoring tool easy to use
- local browser available for the local fruition of the educational products
- fruition of the educational products in Internet
- compatibility with other hypertext formats
- automatic, reliable, secure publishing of hypertexts

We will examine these characteristics in details in the following paragraphs.

2.1 Authoring tool easy to use

The authoring system is addressed to anyone can use a Personal Computer, and who is familiar with the usual Windows interface. IPERtool follows the WYSIWYG (What You See is What You Get) philosophy, and permits the user to see immediately the layout of the page that he is composing in the same way it will appear using an Internet browser.

The IPERtool editor permits to easily change the background and the style of the fonts or to insert pictures, frames, tables, text files, image maps, always working with dialogue windows, thus reducing the effort of memorizing the names of the elements. The built-in help can guide the users when they have problems, and a simple step-by-step tutorial is provided to introduce the tool to the users.

2.2 Local fruition of the educational products

IPERtool can be used to browse hypertexts locally, without the Internet connection. Therefore also users who do not have an Internet subscription can read them, and user who have it can download the applications from the network and browse them locally. The download of a whole hypertext can be achieved in a single step: this characteristic reduces the connection time and permits the users interested in local copy of the application to get it without browsing the hypertext and saving one page at a time.

IPERtool can be distributed as a complete authoring environment, or as a read-only browser together with an application written using the authoring tool, when the aim is the distribution of a hypertext and the addresses should not be able to modify it. With one single button IPERtool allows to print the whole hypertext, a subset of pages or a number of linked pages. In the last case the user can browse the hypertext marking the interesting pages, and the next printing command will have the effect of printing only these pages.

2.3 Internet fruition of the educational products

With IPERtool we overcome the problem of adding networking capabilities to existing local hypertexts [Brown 1994] and the consequent questions about feasibility (is it easy to add networking as an afterthought to an existing hypertext system?), authorship transparency (can networking be added without authors having to change their existing hyperdocuments?) and readership transparency (can networking be added without changing the way readers use the hypertext system?).

The reason is that IPERtool is designed on purpose to produce hyperdocuments that are usable both in a local environment (Personal Computer with MSWindows) and in a networked one (Personal Computer with Internet connection and a WWW browser). Every hypertext written using IPERtool can be viewed with Netscape Navigator or similar Internet browser, and it appears indistinguishable with respect to a hypertext written in HTML. The same functionalities (tables, frames, forms...) implemented in Netscape Navigator are available, and the format of the included pictures, sounds and movies is the same. Also the hypertext keyword management is accessible using a simple built-in form-based interface.

An advantage with respect to hypertext written in HTML is that the whole hypertext is contained in a single file, and the distribution is consequently easier.

2.4 Compatibility with other hypertext formats

The compatibility with other document formats is important in the light of the reuse of information, and in many case teachers have a great deal of didactic material already prepared.

IPERtool has an internal translator which permits the inclusion of hypertexts written using the Windows Help or HTML. In these cases not only the content of the nodes is maintained, but also the structure of links and keywords. Besides that, the inclusion of ASCII text or already written Word for Windows documents is possible and immediate. Furthermore, IPERtool can export either in HTML or in RTF, choosing whether to include or not the link information. In a hypertext written with IPERtool users can include references to standard Internet URLs (for example links to external HTML pages); on the reverse, a standard HTML page can include links to a specified page into an IPERtool hypertext.

These characteristics make the integration of already structured information easy, and the reuse of already written documents and hyperdocuments immediate. A general view of IPERtool import/export capabilities is shown in Figure 1.

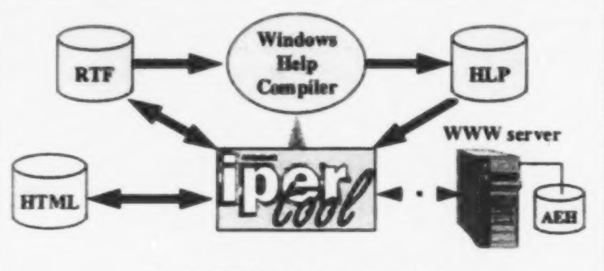

Fig. 1 - IPERtool, a general view.

2.5 Automatic, reliable, secure publishing of hypertexts

The process of publishing in Internet the hypertext written with IPERtool is completely transparent both to the author and to the Webmaster of the WWW server. Once IPERtool is correctly installed on the Internet server, the only thing the author has to do after she has finished with the hypertext is to choose an item on a menu and digit username and password; the hypertext is transferred into her home directory without the intervention of the Webmaster, and without the risk of corrupting other authors' hypertexts. User authentication is provided with a simple MD5 based challenge-response mechanism.

Trained system users or system administrators can however transfer manually the hypertext: they have to send via FTP a single file and write a simple HTML anchor to link it to an existing page.

3 IPERtool

IPERtool [Ghigliano 1997] is made of four distinct components:

1. IPERedit, a WYSIWYG editor that allows the building and maintenance of the hypertext. It is a full visual environment that totally hides to the user the management of the distinct files and media the hypertext is composed of. IPERedit uses a private representation for hypertext (the .AEH file) but it can easily import and export file written both in HTML and in Microsoft Rich Text Format (RTF) [RTF 1994] using the Windows Help Convention (WinHLP) [Microsoft]. HTML pages can be downloaded directly from Internet thanks to a HTTP-browsing capability integrated into the editor.
2. IPERreader, a read-only browser to distribute the hypertext over traditional media like diskettes or CD-ROMs: all the browsing capabilities of IPERedit are provided.
3. IPERserver, a gateway that allows the browsing of an hypertext in AEH format stored in a standard WWW server by a HTTP connection.
4. IPERupload, a server side demon that allows the upload of a hypertext into a WWW server with a simple click of the mouse button. Remote user identity is ensured by a simple MD5-based protocol.

IPERedit and IPERreader have been developed using Borland Delphi, a visual environment that allowed a fast prototyping of the product in the MSWindows environment. IPERedit and IPERreader are fully supported under Windows 3.11, Windows95 and Windows NT 3.5. IPERserver and IPERupload consist of a library of CGI (Common Gateway Interface) scripts developed in C that at present run over Digital UNIX 3.2; they are nevertheless portable over other flavors of UNIX, and over other systems. IPERupload has been easily installed on a SUN to distribute hypertexts to the students at the University of Udine.

Our main goal in developing IPERedit was to help the user not to waste time in taking care of the different files of which a hypertext is made of. The user works all the time with a unique object called the hypertext and all the objects inside the hypertext are stored in a single file: this make the distribution and the maintainance of the hypertext extremely simple. In order to achieve this goal we defined a private binary file format called AEH (Advanced Encapsulated Hypertext) that allows the encapsulation of all the object inside the hypertext. While developing this format we strongly kept in mind the need of an easy conversion to and from HTML and RTF formats.

3.1 IPERedit

IPERedit is a WYSIWYG hypertext editor that has two distinct components:

- the *main window* (see Figure 2) provides a whiteboard on which the hypertext is displayed. The menu bar allows the usual operation, such as opening and saving the hypertexts. A toolbar provides hypertext-related functions: in the reader mode it contains only the basic instruments for navigation, while in the editor mode it provides buttons for hypertext import, objects management, keyword management and switching between browsing and editing modes.
- the *toolbar window* (see Figure 2) provides page-related functions such as text and paragraph formatting and tools for inserting and managing objects into the hypertext. The toolbar appears as soon as the user switches from reader mode to editor mode.

An object oriented approach has been followed to manage the variety of elements inside the hypertext. Each complex item (such as images, image maps and links) can be found in the object table and the user can modify its properties at any time. Inside an hypertext you can find the usual objects of a networked hypertext such as images, image maps, tables, frame sets and multimedia players for audio and video. Links can drive to another page in the hypertext, to a standard Internet URL or to executable or compressed files embedded into the hypertext. Linking objects inside the hypertext is a full visual operation: a window helps to choose from the objects database by giving a preview of the link destination.

3.2 IPERreader

IPERreader is a read-only version of IPERedit. It has been projected to distribute hypertexts in AEH format by traditional means such as diskettes or CDROM. User can browse trough the hypertext using the navigation panel and can access to the keywords database. It's possible make a global search trough the keywords or choose directly a keyword between the sets of keyword inserted by the hypertext author. IPERreader act over the hypertext as the WinHLP interface do.

IPERreader setup information can be customized from the author of the hypertext to display hypertext related information during the installation in a local environment. This allows the distribution of the hypertext together with IPERreader has a single integrated package. IPERreader can be used as a context-sensitive help interface for MSWindows programs using the Microsoft Dynamic Data Exchange. This allows program developers to use IPERedit as a hypertextual help editor for Windows applications.

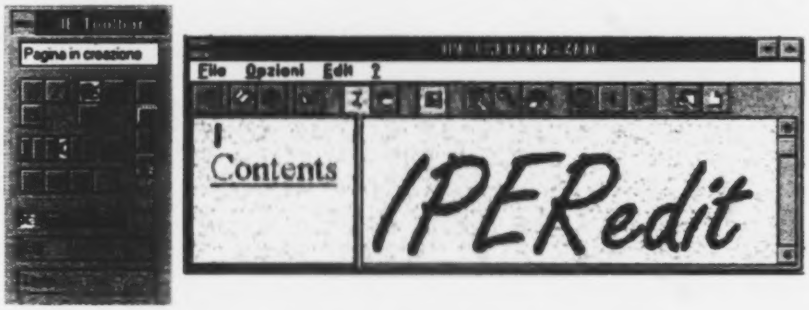

Fig. 2 - IPERedit, the main window and the toolbar window

3.3 IPERserver

IPERserver is a simple Common Gateway Interface (CGI) script that provides on-the-flight conversion from an AEH file to HTML. This make the AEH files stored into the file system of a WWW server accessible to any HTTP client.

As shown in Figure 3, each link of the AEH hypertext is translated by IPERserver into a dynamic self-request. This means that by clicking the link, IPERserver is invoked to display the requested page of the hypertext. Parameters specifying the requested hypertext and page are sent to IPERserver via extra path information, as defined by HTTP 1.0 protocol.

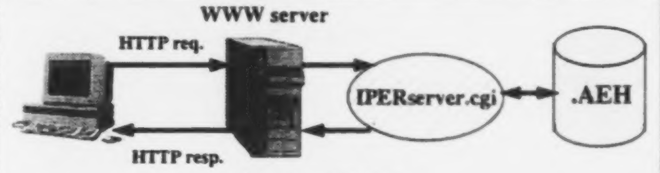

Fig. 3 - IPERserver

3.4 IPERupload

In order to provide an easy way to maintain and distribute hypertexts on WWW we developed a secure CGI front-end to upload AEH files in an hypertext. Trough a connection with IPERupload, an authenticated user can upload a new hypertext or modify or delete an existing one. Uploading is as simple action (the click of a button) in the upload window of IPERedit. The only requirement for the user is to have previously and properly configured his profile providing username, password, the remote location of the WWW server and the directory in which the IPERupload CGI is located. IPERedit can be distributed pre-configured for a WWW server so that the user need only to provide username and password. Hypertexts uploaded onto a WWW server are immediately available for distribution over the Internet through the IPERserver gateway.

As we provide a gateway to write on the file system of a WWW server from a remote IPERedit client, we need an authentication framework to protect unwanted accesses to the file system of the server. Each hyperwriter is uniquely identified by a user name, and a password is required to add or overwrite a hypertext stored in a WWW server. The password is never sent in clear over the network, but an MD5 hash of a challenge phrase is used to authenticate the user to the server. This will protect the password from eavesdroppers that could observe packets flow over the Internet.

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4 Applications

While we are in the process of experimenting IPERtool and of adding new features, we have used it for a number of applications.

A hypertext for teaching the C programming language to students at the first year of a master degree in computer science engineering has been written at Politecnico di Torino using IPERtool. It contains about 2.500 nodes; if it were written in HTML it would have been composed of 2500 different files with the obvious related management problems, but in our case it is only composed of a single file. This application, under the form of two floppy disks that contain also the IPERtool browser, has been distributed to the students both at Politecnico di Torino and at the University of Udine, and it is available on the Web of Politecnico di Torino.

Besides the educational applications, in order to provide a wide testbed to the IPERtool authoring system, it has been provided to Ph.D. students at Politecnico di Torino to create and maintain their personal home pages. We are evaluating the feasibility of using IPERtool as the way to provide real time update to the official courses program of our University, allowing direct access to the courses description hypertext for the teachers of Politecnico di Torino.

5 Conclusions and Future Work

The experimentation of the various features of IPERtool will give us a report of the positive and negative characteristics of the tool. We are in particular interested in the reaction of hypertext authors with no computer science background to see if IPERtool is as easy to use as we intended it to be.

Future work is also directed to provide full compatibility in import/export HTML 3.0 Netscape extensions and to solve minor bugs related to table management. To provide an higher level of security in writing the WWW server file system, a public key based authentication framework will replace the actual based on MD5.

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An Internet Based Collaborative Environment to Learn Information Systems Design

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Abstract : This paper describes an Internet based learning environment for Information Systems (IS) Analysis and Design to supplement classroom based instruction. In this scenario, the relationships among the learning task, the pedagogical model and the supporting technology become a central issue for investigation. The learning environment makes use of on-line multimedia instructional materials, of support tools targeted to engage in the IS design task, including a library of design projects, and of communication and collaboration facilities, including a shared blackboard and videoconferencing. Preliminary evaluation of the adopted pedagogical model with respect to the one applied in the previous editions of the course, by taking into account the students evaluations and course grades is discussed.

1. Introduction

Many attempts have been made in the last years to promote distance learning environments by using both telecommunication and data networks. Among the technologies proposed to support learning at a distance, we identify two extreme situations: television channels and ISDN networks. The first solution does not afford real time interactions between learners and teachers but it allows the wide distribution of lectures at low cost. On the contrary, the second solution privileges real time interactions but at a relatively high cost. Both approaches are typically complemented by electronic mail systems that provide asynchronous communications channels to send questions and receive answers or feedback on assignments. Some communication solutions initially aimed at addressing the needs of distance learning have gradually been adopted in more conventional settings and have resulted in the increasing number of "on line" courses that substitute or integrate the learning experience offered in the classroom. Internet has opened up a much more flexible and rich space for this kind of experimentation, by expanding the range of media formats available for instructional materials and by allowing participants in a learning experience to establish new patterns of communication. However, the pedagogical model underlying traditional distance learning solutions is often a lecture-based one, under the assumption that the most important events in a classroom are the teacher talking and the questions from the learners. The shortcomings of such "delivery" model of instruction are made apparent by recent theories that emphasize the social and cultural nature of cognition and regard learning as an activity based enterprise [Brown et al.,1989]; [Lave & Wenger, 1991], in which knowledge is created by collaboration among social actors who contribute towards the creation of shared understanding of a problem and to its solution.

This paper describes an Internet based learning environment developed for undergraduate students of Information Systems (IS) Analysis and Design to address some shortcomings of classroom based instruction that are especially evident when the learning task is design and a high number of students are enrolled. Design typically requires extensive revisions and feedback from the instructor, and when the complexity of the system to design is relatively high, it often has to be carried out collaboratively by teams of students. All these aspects tend to be penalized with conventional, classroom based approaches to learning.

Current communication and groupware technologies can support approaches to learning enriched by a cooperative mode of interaction based on audio, video and shared documents. Most importantly, such technologies may also afford instructional interactions which otherwise would be extremely difficult, if not impossible, to implement in a traditional environment. Surveys and explorations of the form of support that computers afford to collaborative learning are provided in [Silverman, 1995] and [Crook, 1994]. There are some experiences in the use of distributed collaborative technologies for students engaging in engineering design [Watable et al., 1995], even in a distance learning framework [Andriole et al., 1995], that, though still exploratory, present encouraging findings. Another experience in the use of asynchronous learning networks for information and software systems design is described in [Andriole et al., 1995]. The learning environment is designed to organize materials, classroom discussion and assignments and create a continuous "on line" course. The need of integrating design tools and of making available records of prior teams collaborations for designing a decision support system is emphasized in [Silverman, 1995]. An experience focusing on collaborating on the Internet based on desktop videoconferencing in the context at a distance learning course produced by the Open University is described in [Alexander & Mason, 1994].

This paper can be situated in the context of attempts to integrate resource based learning and low cost collaboration technologies to test both the technological feasibility and the pedagogical effectiveness of the resulting environment. In this scenario, the relationships among the learning task, the pedagogical model and the supporting technology become a central issue for investigation. The learning environment for IS analysis and design proposed in the paper makes use of on line multimedia instructional materials, a set of support tools targeted to engage into the IS design task among which is a library of design projects, and of communication and collaboration facilities, including a shared blackboard and videoconferencing.

2. A Pedagogical Model for Learning IS Design

The proposed pedagogical model has been set up to support an introductory required course in Information Systems Analysis and Design, which is attended by a large number of undergraduate students (typically around 100 per section) in electrical and computer engineering. The main objective of the course is to learn a methodology to develop an IS project, from the requirements analysis phase to the design of the data structures, to the development of a system prototype. The course also covers the theory of relational databases, the fundamentals of a DBMS (i.e. Microsoft Access) to prototype selected aspects of the information system and the architectural concepts of computer networks that are most relevant to IS design (e.g., for performance evaluation). Whether a course can considered successful or not is largely a matter of the overall level of interest and engagement generated in the learners, who can thus find the intrinsic motivation to overcome the technical difficulties and reach the level of competence required. To this aim it is important to structure a learning experience that is authentic enough to be motivating and still technically well supported. It is not a case that dimensions such as interest, perceived usefulness of the contents, quality of the materials, efficacy of their use are now included in the institutional course evaluation forms, to gather feedback from the students on the quality of the overall learning experience. How to incorporate such "metaobjectives" in a pedagogical model to address the main learning challenges for novice IS designers and the role that technology can play in this enterprise is the main concern of the paper. In the following, peculiar aspects of the IS design learning tasks are elucidated to discover pedagogical and technological opportunities.

A first issue to consider is that effective communication in IS analysis and design requires media more expressive than text, because concepts of networks (e.g., queue theory for performance evaluation) and formal description techniques (such as automata or Petri nets for modeling system's behavior) have a strong dynamic component difficult to capture. Using hypermedia (e.g., colour, sound, animation, and links) prepared by the instructor to illustrate such concepts in the classroom is therefore the more adequate solution, and a fundamental part of the pedagogical model with respect to the communication issue. However, to sustain the immediate communication benefits such materials should be available for personal study and revision, given the difficulty in taking notes in real time.

A second issue concerns facilitating learning by expert modeling of the task and of the related metacognitive activities [Collins et al.,1989], especially for those aspects not fully addressed by the design methodology, that are: 1) capturing the requirements's specification in a conceptual model of the system and 2) the transition from the conceptual model (functions and entities) to the logical architecture of the system to implement (i.e., the design of software modules and tables). Concerning design metacognition, a skill to develop is how to verify the consistency and completeness of the system's specification, and monitoring that heuristic criteria of good design are met. However, in the context of classroom based courses, the instructor can model for the learner the above activities only few times, focusing on selected examples. Also, it is difficult for the instructor to interact extensively with the students for individual guidance on their projects and to provide feedback at intermediate stages of design, due to the high number of students and also to the fact that part of the available time is spent in repeated patterns of clarifications to different groups. A first solution to this problem is to create a base of annotated IS projects produced by the students in the former years of the course [Faro & Giordano, 1996]. A variety of cases available for inspection can foster cognitive flexibility [Spiro et al., 1988]. In addition, the base opens a "window" on the reasoning processes of peers and can indirectly support metacognition.

A sound pedagogy must take into account that IS design is inherently a collaborative task. Because of the complexity of the systems to design many actors with different purposes and competencies are involved in the process: designers, clients, users, implementors. Students are therefore encouraged to undertake the major assignment of the course, i.e., the development of a project, in groups of two or three; this form of cooperation is important first because the team tries to sort out collaboratively issues regarding the interpretation and application of the design methodology; and second because it provides a microworld of the realities of professional life as designers, in which communication and reasoning skills can be cultivated. On the other hand, especially in classroom based courses with large numbers of students there is often a lack of awareness regarding what other teams of peers are doing. This rules out opportunities for exchanging design experiences among teams who are tackling problems in similar domains.

Models of cooperation based on teams of students tackling their own design project, e.g., [Dietrich &Urban 1996] still do not address the problem of limited exposure to varied design situations and design solutions and of how to scaffold the learner. Concerning scaffolding, we have proposed to integrate this aspect directly in the IS design methodology, by introducing a method of analysis of the system based on stories that formalize the interactions taking place in the IS system [Faro & Giordano, 1996]. The integration of story based reasoning in a methodology for IS design provides a well-received framework that the learners use to focus their attention in selected but meaningful parts of the system, thus reducing the cognitive load involved.

Having the above scenario in mind, IBLEDIS (Internet Based Learning Environment for Designers of Information Systems) has been deployed to supplement classroom lectures by implementing some components of the above pedagogical model to enhance and augment the experience of each individual learner.

3. IBLEDIS: Architecture and Use Cases

IBLEDIS is organized according to three main groups of functionalities, as shown in [Fig.1]:

1. Support to the students with respect to the contents and organization of the course, targeted for the initial part of the course, in which the fundamental concepts to engage in the design task must be acquired.
2. Tools and resources to scaffold the design task, from the conceptual and technical point of view.
3. Functionalities to address public and private communication and collaboration needs.

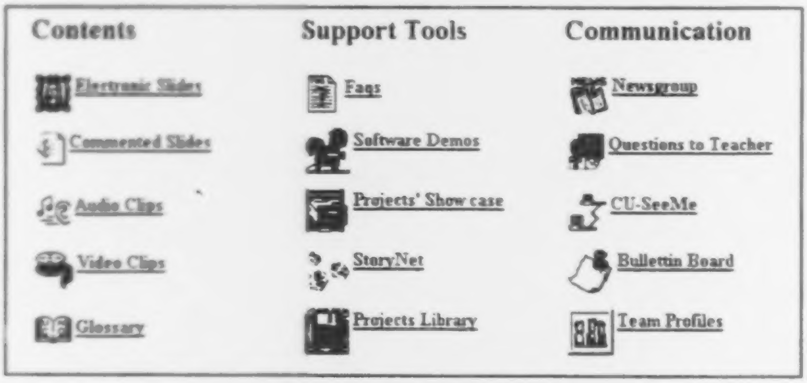

Figure 1: IBLEDIS main menu

Students access IBLEDIS using Netscape from their PC, as illustrated in the architecture of [Fig.2], either to download the learning resources (contents and design support tools) or to use them on line, likewise a stand-alone hypermedia program, the latter choice being made to facilitate students who can only access IBLEDIS from the university computing services. To make full use of the IBLEDIS resources the clients PCs need the client versions of the software VDOlive, Iwave , and Cu-see-me, respectively managing videoclips, file audio, and videoconferencing. A Connectix Quickam is used for the video options of the Cu-SeeMe software. A PowerPoint viewer and Lotus ScreenCam player are used to view the hypermedia instructional materials.

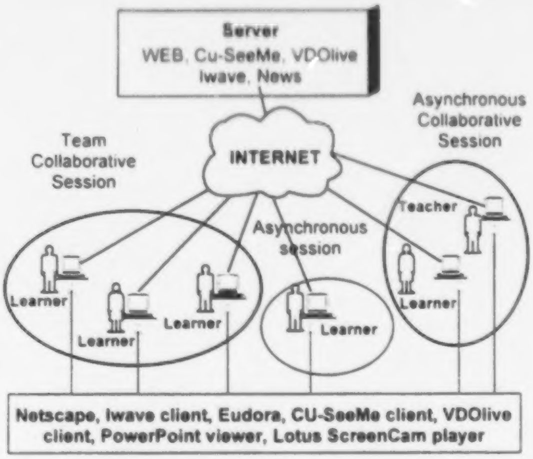
Server
WEB, Cu-SeeMe, VDOlive
Iwave, News
Asynchronous Collaborative Session
Team Collaborative Session
INTERNET
Teacher
Asynchronous session
Learner
Learner
Learner
Learner
Learner
Netscape, Iwave client, Eudora, CU-SeeMe client, VDOlive client, PowerPoint viewer, Lotus ScreenCam player

Figure 2: IBLEDIS architecture

At the beginning of the course students are asked to watch a short introductory videoclip, currently produced with VDOLive Technology, which mainly serves to highlight the relevance of the main topics of the course. The students are requested to study each topic by using as learning resources the electronic slides projected during the lectures. The slides, produced in MS PowerPoint, can be either downloaded as the complete set for each topic or they can be viewed on-line. In the second option, the student can ask to listen to the audioclip related to the slide by clicking the relevant icon. These audioclips are managed as separate files by the VocalTec Iwave client-server technology. The FAQ icon is context sensitive and provides links to the FAQs related to the slide. The glossary is also available to retrieve a definition of the unknown terms and to allow the cross-referencing of topics with the FAQs. The bibliography icon is also context sensitive and provides the references to sources and articles for further readings on the topic at hand.

A News Group facility is available to post question to the teacher and to all the other learners or to browse for useful posted messages. The news group has been organized according to discussions on specific topics and project proposals. Announcements regarding "public" feedback sessions are posted in the bulletin board.

After the students have acquired the basic theoretical concepts, they are requested to develop in teams a project that they will present for their final exam, and the core of the design learning experience begins. This phase is characterized by a change in the collaboration needs, in the tools to support learning and in the kind of feedback required from the instructor. As outlined in the previous section, the students' Projects' Library turns out to be a critical resource to support the phase of conceptual modeling (e.g., system's analysis) by increasing the number of available cases and solutions. These projects are a significant portion of the accumulated memory of the course, and are indexed by domains, by patterns of use-stories of the information systems. Projects developed in electronic format can be downloaded. The projects' library plays an important role in the initial phase of the design exercise, in which teams choose their domain application and examine the available relevant projects to check for aspects that they have not captured in their initial conceptual model of the IS system. Once the main components of such model have been outlined, team collaboration focuses on deriving the data flow diagram, the entity model, on dimensioning the system and on developing a prototype.

In this stage the students start asking for the available SW tools to assist the project development. Currently, two tools developed in our lab, i.e., StoryNet, a design environment to structure the project in stories, and a visual program to perform computer network performance evaluation are given to the students. Other tools are available at the computing center to prototype the information system. To facilitate their use, and minimize the

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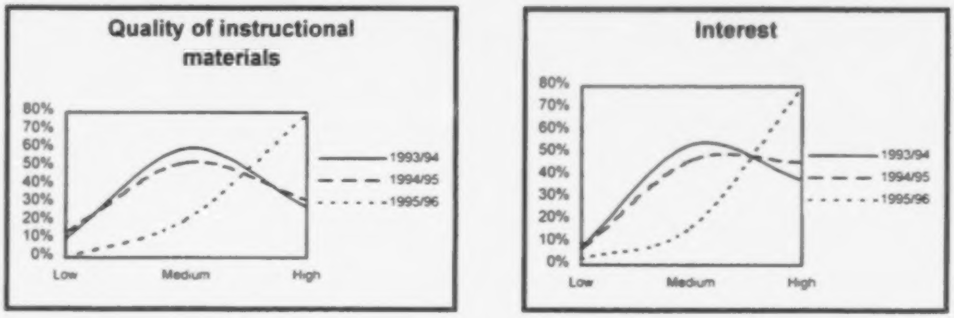
time spent on lab demonstrations, a set of software demo clips is available on demand via Internet aiming at demonstrating how the tools work. These demos, likewise the commented slides, have been produced with LOTUS ScreenCam technology, which allows recording all the activities taking place on the screen, including audio comments. The students also have the possibility to ask the members of their team or the instructor to open a synchronous working session by using the conferencing and the shared blackboard facilities offered by the WhitePine version of the Cu-SeeMe software.

4. Evaluation and concluding remarks

IBLEDIS partially implements the pedagogical approach to learn information system design discussed in the former section with respect to providing a flexible access to the learning resources and to fostering various forms of collaboration. Regarding IBLEDIS effectiveness in supporting engineering students to learn information systems design and in addressing the quality dimensions of the instructional experience outlined in section2, we have some preliminary results based on patterns of use, students' evaluations, and grades measuring the quality of the final design. Among the components of the environment mostly appreciated are for their usefulness: 1) the slides distribution via Internet together with related audioclips; 2) the commented slides related to the illustration of dynamic concepts; 3) the use of the newsgroup facilities to discuss the projects proposal; and 4) the consultation of the library of the already developed projects.

From the comparison of the evaluation forms of the course of the last three years we have some indications on how some components of the pedagogical model, in conjunction with IBLEDIS have affected the students. Evaluation forms in the academic year 1993/1994 correspond to an instructional condition of a traditional approach to the design classes; in the academic year 1994/1995 the story based scaffolding was introduced and the set of electronic slides with animation was used only during the regular classes; in the academic year 1995/1996 these materials were made available via IBLEDIS, together with the projects' library and the other above described support tools.

Students evaluations of the course organization and of the supporting learning environment concern quality of instructional materials, interest in the course, comments on the perceived quality of design labs. Quality of instructional materials in the third condition has been considered high by the 89% of the students [Fig.3a]. The significant variation from the patterns of the previous years can be considered an effect of IBLEDIS, in terms of organization and direct availability, because the text based materials have been unchanged, and the same electronic slides were used, but not distributed to the students in the year 1994/1995. A promising effect has been noticed in the increased students' interest [Fig.3b] and in how the quality of the labs are perceived [Fig 4].



(a) (b)

Figure 3: Student's evaluation of quality of instructional materials (a) and interest in the course (b)

This might be an effect of more time available for the instructor to model ill-structured aspects of design, and by an increased readiness of the students that, based on better materials and story-based scaffolding, overcome more easily some initial difficulties. Concerning the grades, we have noticed an interesting effect according to which in the second and third condition more students perform better, and the number of students whose performance is average decreases. Of this set, most students can move up in the grade scale, whereas some tend to get grades slightly lower than they used to get in the first instructional condition, i.e., without following the story based methodology and without the resource support of IBLEDIS.

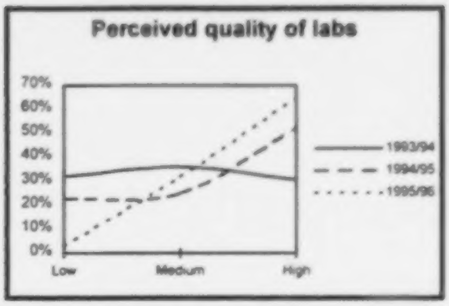


Figure 4: Student's evaluation of quality of course labs

A possible interpretation is that this is due to a better discriminatory power in the quality of the project entailed by the story based methodology. This preliminary figures have been derived by standard evaluation forms that were not specifically designed to investigate IBLEDIS, and from the official grades.

At the current stage IBLEDIS can be considered successful regarding supporting asynchronous collaboration, in the form of clarification and interactions with the instructor, in increasing the number of perspectives that may be offered on the same design issue; and to increase in the overall number of design situations to which each individual learner can be exposed. Another issue requiring investigation is whether patterns of interactions and collaboration (among learners, and among learners and instructor) can be effectively and naturally established over Internet based on the videoconferencing component, and enrich the processes that are instantiated within a face to face group meeting while jointly producing an artifact. So far, the implementation in IBLEDIS of our pedagogical model is not full fledged. The current development efforts are targeted on creating a project library that has the full functionalities of a case based reasoner and is accessible from remote, and on including in making it evolve based on the students and instructor annotations.

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Virtual-U Development Plan: Issues and Process

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Abstract: This paper reports on key issues examined by a cross-disciplinary research team involved in the development of Virtual-U, a Web-based intentional learning environment for post-secondary course delivery which supports collaborative learning and knowledge building. Section 1 describes Virtual-U itself. Key research issues are presented in section 2. These range from user interface design questions such as navigation support and use of multimedia to the pragmatics of communication and social interaction in shared workspaces. Addressing these issues necessitates a broad cross-disciplinary research approach that informs the design process in an iterative testing/design cycle described in section 3. In section 4, we discuss a possible course for the evolution of Virtual-U into a more richly textured collaborative learning environment, using a smooth upgrade path and interactive design to maximize transfer of knowledge and experience as the system grows.

1) Background

Virtual-U is a World Wide Web-based integrated set of software tools and templates enabling the creation, delivery and enhancement of on-line courses that is being developed under the direction of Linda Harasim and Tom Calvert by the Telelearning National Centre of Excellence. Virtual-U is intentionally designed to enable and facilitate asynchronous discussions, collaborative learning and knowledge building (see [Harasim, Hiltz, Teles, and Turoff 1995] for background). Users require a workstation, a Web browser (Netscape Navigator or Microsoft Internet Explorer), and access to the internet. Course delivery requires setting up the course on a Web server hosting the Virtual-U software. Virtual-U's current functionality includes the following components:

- Creating course Web pages
- Structuring interactive discussions and collaborative activities among students, teacher and external participants
- Creating shared resources for knowledge building
- Class management and evaluation

Course design support includes guidelines for setting learning outcomes, instructional techniques, evaluating learning outcomes, "netiquette", discussion or project group design, learning activity design, and course syllabus creation. Ancillary discussion groups can be set up within Virtual-U to allow groups of teachers and/or support staff to discuss instructional strategies, support issues, etc. Course design support consists of guidelines for setting learning outcomes, instructional techniques, evaluating learning outcomes, netiquette, group design, activity design, and course syllabus design. There is also a facility to allow users to share their own tips and experiences with other users.

VGroups is Virtual-U's Web-based computer conferencing component. Using Vgroups teachers can create discussion groups that mediate students' on-line communication according to different discussion modes such as topical discussion, debate structure, role playing, etc. Activity templates and tags can help to scaffold particular activity types. Discussions can be set up as course-related or entirely social (as in the students' informal "Cafe" discussion environment). Messages can be sorted and viewed by topic (i.e. "thread"), date or author (See Figure 1.). Users can imbed either URLs or HTML in messages to incorporate hypermedia links to other Virtual-U Web pages or other Web sites. This is one of the ways in which Virtual-U supports the learners' interaction with shared resources. Other means include a file manager for uploading or downloading files, tools for creating concept maps and tools for annotating documents. Virtual-U's on-line grade book provides a class management tool that is configurable to allow students to view their own grades as well as a graphical representation of the class distribution, or to read a qualitative assessment of their work by their teacher.

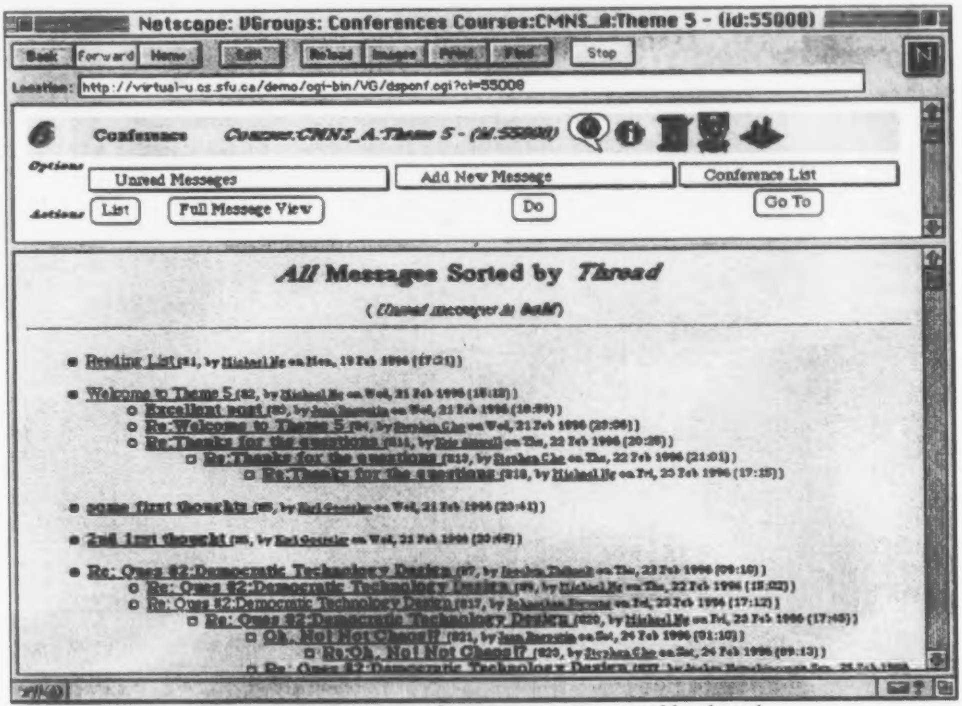
Netscape: VGroups: Conferences Courses:CMNS_A:Theme 5 - (id:55008)
Back
Forward
Home
Edit
Reload
Images
Print
Find
Stop
Location: http://virtual-u.cs.sfu.ca/demo/cgi-bin/VG/dsponf.cgi?ci=55008
Conference
Courses:CMNS_A:Theme 5 - (id:55008)
Options
Unread Messages
Add New Message
Conference List
Actions
List
Full Message View
Do
Go To
All Messages Sorted by Thread
Reading List
Welcome to Theme 5
Excellent post
Re:Welcome to Theme 5
Re:Thanks for the questions
Re:Thanks for the questions
Re:Thanks for the questions
some first thoughts
2nd 1rst thought
Re: Ques #2:Democratic Technology Design
Re: Ques #2:Democratic Technology Design
Re: Ques #2:Democratic Technology Design
Re: Ques #2:Democratic Technology Design
Oh, No! Not Chaos!?
Re:Oh, No! Not Chaos!?
Re: Ques #2:Democratic Technology Design

Figure 1: V-Groups conference messages sorted by thread.

Class management and evaluation is supported with an on-line grade book which can allow students to view their grades, the distribution of grades as a bar chart, and qualitative assessment of their work. Instructors may manage grades entirely on-line or upload from a local spreadsheet to the grade book.

Navigation of Virtual-U is based on a campus metaphor (see Figure 2) to create a sense of familiarity for newcomers to on-line learning.

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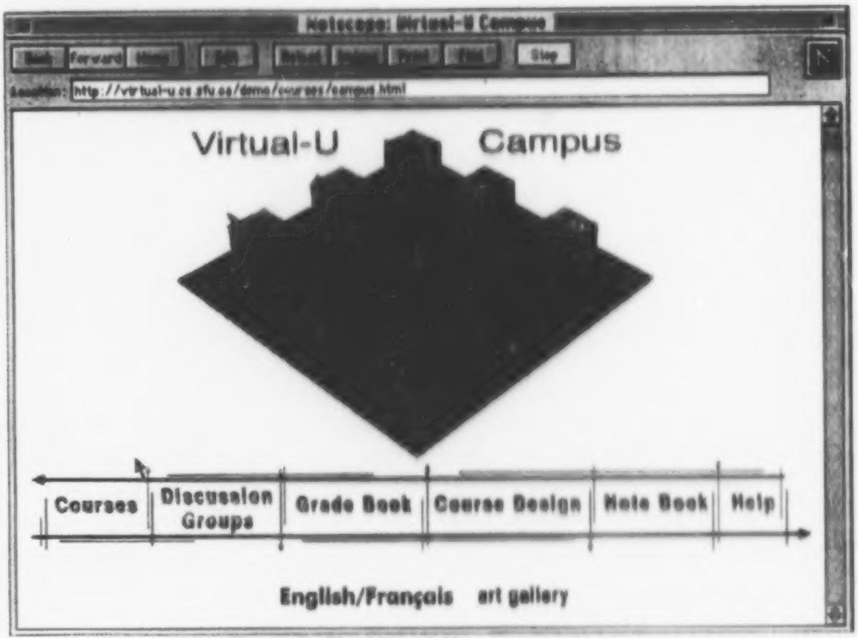

Figure2: The Virtual-U campus main page

2) Research and design issues

Virtual-U is being developed within an academic context to provide a tool specialized for the delivery of post-secondary courses. The developers are sensitive to the broad range of design issues that might determine the success or failure of the software in mediating the learning process. In order to insure that Virtual-U effectively supports the pedagogical principles of knowledge building and collaborative learning, a Cross-Disciplinary Research Design group (CDDR) was assembled. Current members of the group are drawn from Communication/Education, Cognitive Science/Psychology and Computer Science. Our intention is to expand this group to include a broader range of the Social Sciences (e.g. Sociology/Ethnic Studies).

In collaboration with the Human-Machine Interface group of the Institute for Robotics and Intelligent Systems, CDDR is applying new methodologies to the study of the perceptual, cognitive, and social aspects of shared multimedia learning environments. Much of this work is at an early stage of development, but it has already had a significant impact on the design of Virtual-U.

a) Navigating in the virtual university.

One focus of work deals with the interaction of perceptual systems and higher-order mental representations (the so called "cognitive architecture"; [Pylyshyn 1991]) of events in space. A major cognitive framework for individuating, visualizing, and keeping track of different items of knowledge (such as who said what in a conference or what items of data go with what) is the use of real 3D spatial locations. We use space both literally (as in the desktop or office model of data organization) and also figuratively. Examples of the latter includes such techniques as mentally locating different facts and premises in certain imagined spatial loci -- a technique widely used in mnemonic aids, and the use of spatial location in reasoning where so- called "spatial paralogic" provides an important scheme for keeping track of different components of a problem. Understanding and supporting the effective use of spatial reasoning with perceptual cues could greatly enhance users' ability to understand complex problem domains.

Existing hypermedia navigation tools utilize high-level cues (e.g. landmarks, memory aids, and shortcuts) to aid users in determining their position within a complex hypermedia document. This often requires a difficult cognitively mediated dynamic mapping task to be done in tandem with users' main tasks, straining users' attentional

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capacity. In daily life, a set of low-level mechanisms enables us maintain a consistent mental model of a stable world despite rapid and frequent shifts of retinal images due to eye, head and body movements. Recent work in Cognitive Science [Pylyshyn 1994]; [Goodale and Milner 1992]; [Bridgeman and van der Hejiden 1994] has led to a better understanding of the interaction of perceptual events in visual space and central processes. In collaboration with basic researchers, we are applying these theories to the design of data spaces for improved understanding and easier navigation. One example of this is a Web navigation tool called CZWeb, which uses animation, hierarchial organization, and detail-in-context views to provide a dynamic spatial representation of portions of the Web.

b) Understanding modes of interaction of multiple users in shared spaces

Optimizing social facilitation and active collaboration in educational environments requires users to integrate the synchronous/asynchronous actions of multiple users in the same knowledge space. This requires users to accurately attribute repercussions of an action to the correct cause and the correct actor. The critical theoretical issues again revolve around users' internal representations of objects and events in shared perceptual, cognitive, and motor space. Spatial indexing (FINST) theory can help us to find low- level cues to tie together effects and actions, allowing multiple users to operate on the same information set in a cooperative manner. These mechanisms have been examined in the laboratory [Pylyshyn, Burkell, Fisher, Sears, Schmidt, and Trick 1993], but remain to be tested within the context of Virtual-U.

c) Information channeling in a multimedia environment.

Knowledge building tools need not be limited to graphical displays. The effective use of sound can increase the amount of information that can be understood, while reducing the demands placed upon the already overburdened visual channel. Optimal use of auditory displays requires a greater understanding of how they interact with visual displays in scene understanding, active perception, and direct manipulation tasks. Previous work by [Fisher and Pylyshyn 1994] and others has suggested that different tasks appear to utilize different multimodal integration cues, and so may evaluate visual and auditory sources of information in different ways. Since computer display environments often produce errors in these cues (e.g. asynchronies, location errors and poor quality renditions) this can affect the interaction of sonic and visual displays. Ongoing research by the IRIS human interface group on spatial sound displays and sonification of work environments should transfer to a variety of telelearning applications, particularly in the development of virtual laboratories for learning technical and performance skills.

d) Communication strategies for collaborative learning.

The low-bandwidth of computer-mediated communication tools can give rise to conflict and misunderstanding among users. The impact of this on existing networks (such as USENET) is great, and extension of networked communication technology to new user groups exacerbates the problem. Another focus of our work applies Psycholinguistics models [Grice 1975]; [Clark and Wilkes-Gibbs 1986] to address the pragmatics of social interaction and communication over limited bandwidth channels. Face-to-face communication is to a great degree mediated by conversants' knowledge of their common ground of shared referents, which is largely created and maintained by the use of non-verbal cues such as expression and gesture. In designing a collaborative environment, care must be taken to insure that the "social bandwidth" that enables users to disambiguate their language (a process known as "grounding" [Clark, and Brennan 1991]) is maintained. An examination of the V-Groups productions from different groups of users (i.e. completely on-line vs. mixed-mode) combined with laboratory testing will help us to determine the effects of the bandwidth limitations that are imposed by technology on communication, and how students compensate for these limitations. This in turn will help us to better design the interface for more effective communication.

e) Cultural and social factors in the use and acceptance of distributed education.

Acceptable metaphors for learning may differ between various ethnic groups, socio-economic strata, and age cohorts. In addition, computer-supported collaborative learning will result in the formation of study groups that may include users who differ in age, sex, ethnic and cultural backgrounds. We are actively seeking to expand the diversity of our user community so as to learn ways to better support the inclusion of diverse user populations. Ongoing assessment should be conducted during implementation in order to insure that the interface is optimized for a diversity of users.

3) Process

a) Iterative design.

A lack of data from large-scale real-world use of comparable collaborative learning environments required us to begin by building a relatively simple system in a short time frame that could be tested in a broad-based field testing program. Results of these tests would lead to design changes that would in turn be tested in field sites and in our interface testing laboratory. This insures that design changes benefit from the input of real users of the system.

b) Large-scale field tests

A major difficulty in building a robust general-use computer-supported collaborative learning environment is that it must serve a broad diversity of students, instructors, subject materials and instructional styles. Small-scale user tests are unlikely to provide a representative sample of this heterogeneous population. Our current field testing program serves approximately 730 students, and is as broad-based as possible.

c) Integrated data analysis

Converging evidence from a variety of measures and testing situations is combined to give the broadest possible perspective on the utility of Virtual-U. Field site participants are surveyed by questionnaire, and their interactions (i.e. server requests) with the Virtual-U Web server are recorded. Parsing the server requests into user actions is problematic, as a simple activity may generate a number of hits. User testing data can help to establish correspondence between activities and server requests by comparing patterns of Web server requests in the field and in the laboratory. Identification of characteristic patterns of server requests that are associated with particular situations and user actions allows us to bridge the gap between laboratory and field studies, allowing more precise analysis of events in the field.

Taken by itself, this data set provides useful information about overall user satisfaction and use patterns. In addition, the quantitative data set can be used as a window into the rich qualitative dataset of instructors' and students' productions in conferences and elsewhere in Virtual-U. By identifying specific populations of users and situations, the quantitative data analysis can select subsets of conference productions for the more resource-demanding qualitative content analysis using Nudist or similar analysis tools.

Field testing provides us with a dataset which has excellent external validity, insuring representative sampling of the broad population of users and uses. It has three drawbacks, however. First, it is difficult to conduct true experiments due to the overhead in distributing and supporting multiple versions of the system (e.g. control and experimental versions). Second, collection of useful performance variables such as reaction time, individual keystrokes, etc. is impractical due to the number and wide distribution of users over the Internet. Finally, the lack of control over (or even knowledge of) obscuring variables such as location, data transmission speed, system characteristics, etc. limits our ability to assign observed differences in performance to system variables. Thus,"fine tuning" the system requires laboratory testing, which must then be examined within the context of the field site data.

4) Future Work/Enhancements/Directions

The final aspect of the Virtual-U design philosophy that we would like to discuss is the need for a smooth upgrade path. Current field site students and instructors should benefit from their expertise with older releases as they make the transition to our more advanced designs. While the final design of each release will be determined by laboratory and field testing results, current design plans are to augment the collaborative aspects of Virtual-U by the use of specialized activity scaffolds.

Our current version of V-Groups is relatively unstructured to provide maximal utility for a wide variety of collaborative tasks and methods. Structure is provided by topics, threads, and keywords within a conference, and conferences themselves are structured heirarchially. Within a discussion, students and instructors have complete freedom of use of these organizational cues. This free-form discussion requires users to exhibit considerable discipline in their implementation of the organizational cues provided.

Future versions of V-Groups are likely to maintain this level of freedom for "brainstorming", while providing a richer language of reference to previous messages. We can then use the pattern of interconnections between messages to structure a graphical depiction of the knowledge space created by the free-form discussion. We are currently testing CZWeb, a Web structure visualization tool developed at SFU that provides many of these functions. CZWeb provides users with an animated map of a potion of Web space, where pages and groups of pages are displayed graphically with visible links. Users can manipulate this map, grouping pages in nodes, zooming in and out of regions of the map and so on.

The graphical depiction of a largely text-based set of collaborative messages is the first step towards the creation of a graphical knowledge space, which can then be manipulated by more structured collaborative tools such a planned debate tool. The knowledge space thus created provides a conceptual "lumber yard" which can be used for hypothesis creation and testing, as users create new links that may themselves contain meaning (e.g. "is an example of", "supports", "is a test of" etc.). Other types of tools might instantiate specific roles or perspectives on the data space with a customized quiver of specialized productions possible. Students might adopt the role of the Skeptic, or the Empiricist (or the Fool), operating upon the data space in the appropriate manner.

Much of this work is in the early stages, and will benefit from the experience of the field site participants and from input from colleagues in a wide variety of fields. We are seeking to expand the number and diversity of CDDR members, particularly in the neglected areas of the Social Sciences that deal with cultural and social issues. As we succeed in this, we will no doubt experience increased difficulty in bridging the gaps between our own members. Our hope is that this effort will bear its rewards in an effective collaborative learning environment, deeply rooted in the theoretical and practical aspects of distributed collaborative learning.

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Hypermediated Learning: Learning Styles, Path Analysis, and Knowledge Outcomes

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Abstract: This paper discusses the results of a study to determine the effects of prior computer use, student rank, and differences in levels of field dependence/independence on learning outcomes within a hypermedia program for preservice teachers in special education. No differences were found for achievement, construction of concept maps, on-line test scores, or problem-solving scores which were related to prior computer knowledge, student status, or learning styles. Participants with differing learning styles used the program an equivalent amount of time and accessed information similarly. Differences were found in the proportion of time they spent across two of the four hypermedia instructional components but these differences did not influence learning outcomes.

1 Introduction

In spite of current enthusiasm for hypermedia-based instructon, most researchers agree that insufficient evidence exists to determine whether outcomes match the proclaimed promises of hypermedia. Because hypermedia can provide a flexible, efficient, nonlinear, and associative learning environment, educators have embraced its format without sufficient research on its effects (Liu, 1994). As stated by Harmon and Dinsmore (1994), "most developers assume that, because hypermedia *ought* to be good for instruction, it *is* good for instruction" (p. 157). The excitement for the approach largely rides on the notion that learners *can* and *will* customize their instructional choices in a hypermedia program to fit their preferences and learning styles. Limitations to hypermedia have also been cited (Jonassen, 1989), and it may be that hypermedia is not suitable for all learners.

Research is in its infancy in studying relationships of learner characteristics, hypermedia formats, patterns of use, and learning outcomes. To date, existing research is sparse on a number of these factors and what exists is difficult to synthesize due to differences in lengths of treatment, subjects, features of the hypermedia programs, and outcome measures. This study focused on learning outcomes for adult learners utilizing a robust hypermedia program in a lengthy treatment.

2 Research Questions

The study was designed to address the following research questions about hypermediated learning:

(a) Is there a relationship between prior experience using computers with learning outcomes of students using a hypermedia-based instructional program?
(b) What effects does a hypermedia-based instructional program have on learning outcomes for preservice teachers representing two class ranks and different levels of field independence/ dependence?
(c) Do preservice teachers with different levels of field independence/dependence utilize a hypermedia learning environment differently with regard to engagement time and patterns of accessing information?
(d) Do preservice teachers with different levels of field independence/dependence perform differently in a hypermedia learning environment with regard to mastery of content and on-line problem-solving activities?

3 Treatment: The Hypermedia Instructional Program

3.1 Instructional Content and Purpose

The hypermedia program used in this study was *Perspectives on Emotional and Behavioral Disorders* (Fitzgerald, Semrau, Kraus, Nichols, & Glickert, 1995). The materials utilize a case study format featuring three youngsters with behavioral problems in school settings. Each case study includes an opening challenge scenario and case information presented via software, audio and video support materials residing on a videodisc. Users explore information from a variety of theoretical perspectives by: (1) observing children in a variety of situations; (2) "interviewing" their teachers and parents; (3) seeking background knowledge and case information; (4) comparing and contrasting multiple theoretical views; (5) hearing "experts" discuss the cases; and (6) engaging in problem solving and planning activities within the case studies.

3.2 Underlying Instructional Design

Through the interactive case study approach, the learner is expected to develop a cognitively flexible understanding of the complex, multiple theories and approaches used in formulating intervention programs for students with emotional and behavioral disorders. "Cognitive flexibility" involves the *selective* use of knowledge to *adaptively fit* the needs of understanding and decision making in a particular situation. "Ill-structuredness" means that many concepts (interacting contextually) are pertinent to a specific case, but that their patterns of combination are inconsistent across case applications of the same nominal type (Spiro, Feltovich, Jacobson & Coulson, 1991). The instructional approach utilized in this program strives to develop cognitive flexibility to enable the learner to construct knowledge based on complex and irregular situations. It focuses on the construction of knowledge structures and the application of that knowledge structure to problem solving.

Cognitive flexibility can be enhanced through effective design of hypermedia programs by situating problem solving in authentic case scenarios, providing factual and procedural knowledge within the discipline, scaffolding the learner through guided activities and embedded structure, and modeling the reasoning processes of experts. To evaluate the success of the hypermedia design to develop knowledge and cognitive flexibility, variables related to knowledge acquisition, concept development, cognitive re-structuring, and problem solving must be examined.

3.3 Software Audit Trail

The computer program contains a complete data collection system to capture usage data and learning outcomes through an audit trail (Misanchuk & Schwier, 1992). The datapath for the user provides a continuous record of the user's sequence through the various components and activities and time spent in each component. The written records entered into the computer problem-solving activities are stored in separate files on floppy disks.

4 Participants in the Study

Subjects were twenty-three preservice teachers enrolled in a methods course in behavioral disorders. All students had completed foundational coursework in special education and had substantial prior knowledge upon which they began to develop specialized knowledge in the area of behavioral disorders. Demographic information for the participants served as independent variables.

Prior Computer Experience

Almost all participants had experience using computers for general productivity tool uses, particularly word processing. Most students had never experienced hypermedia programs and only two students responded that they had "some knowledge" of hypermedia. Based on a scale where students rated their experience from 0 = "no knowledge" to 9 = "expert knowledge" on 9 categories of computer applications (total score possible = 81), the mean prior experience score = 25, standard deviation = 10.78, range = 5 to 43.

Rank in School

The participants included 17 seniors and 6 post-bacculaeareate/graduate students.

Learning Styles

Participants represented a mix of field independence and field dependence as measured by their scores on the Group Embedded Figures Test (Witkin, Oltman, Rashkin, & Karp, 1971). Using quartile scores to segment the participants into learning style groups, 4 participants were classified as field dependents (FD), 11 as field dependents mixed (FDM), 5 as field independents mixed (FIM), and 3 as field independents (FI).

5 Data Collection for Dependent Variables

Data were collected prior to use of the hypermedia program (pre) and following completion of the last case study (post). A *knowledge test* consisting of 25 multiple choice questions was constructed from test banks available for two of the primary textbooks used in the field. The content of the information base contained within the hypermedia program was consistent with the content of the textbooks and the knowledge test.

Each student constructed a *concept map* prior to use of the hypermedia program (pre) and following completion of the last case study (post). The maps displayed how each student would organize his or her approach to understanding a child with a behavioral disorder. The concept maps were constructed during supervised class time within a 30-minute time frame without the use of notes or advanced notice of the activity. Each concept map was scored for (a) number of unique concept nodes, (b) number of links between nodes, and (c) number of levels constructed in the concept maps.

Path analysis data were collected from records stored on user floppy disks. Data collected from the audit trail included (a) total time spent on each of the case studies, (b) total time spent in each of the program choices, (c) the number of times each program choice was accessed, (d) results of an on-line quiz embedded within each case study, and (e) electronic responses to all on-line problem-solving activities included within the case studies.

6 Data Analysis and Results

6.1 Outcomes Related to Prior Experience with Computers

Simple regressions were run to evaluate whether outcomes of hypermedia-based instruction were related to differing levels of prior experience with computers. Table 1 presents the regression results for four dependent outcome variables: a) knowledge test, b) number of unique concept nodes on concept maps, c) number of links on concept maps, and d) number of levels included in concept maps. Regressions were run for pre as well as post outcome scores. No significant relationships were found to indicate that prior computer experience was related to differences in pre-treatment scores. Similarly, no significant relationships were found to indicate that prior computer experience predicted learning outcomes based on hypermediated instruction.

	Pre Treatment			Post Treatment		
	r	*F*-value	*p*	*r*	*F*-value	p
Knowledge score	.129	.357	.557	.164	.357	.557
Number of unique concept nodes	.060	.976	.786	.060	1.544	.228
Number of links	.156	.523	.477	.020	.523	.477
Number of levels	.146	.460	.505	.029	.018	.896

Table 1. Outcomes for Students Blocked by Prior Experience with Computers

6.2 Outcomes Related to Student Rank in School

To evaluate whether hypermedia-based instruction affected the learning outcomes of preservice teachers with different levels of higher education, four dependent measures were examined for users blocked into two groups: undergraduate students and graduate/post-baccalaureate students. Table 1 presents the results for two-factor ANOVAs for the dependent variables: a) knowledge test, b) number of unique nodes on concept maps, c) number of links on concept maps, and d) number of levels on the concept maps. Results are included for the group (rank) and outcome (pre/post) main effects. Findings revealed no significant differences in learning outcomes using the hypermedia program which were related to student rank in school.

	Undergraduate Post Mean	Graduate Post Mean	Rank *F*-value	*p*	Pre/Post *t*-value	p
Knowledge score	18.88	18.17	.639	.434	106.147	.001 *
Number of unique nodes	48.24	52.50	1.291	.269	9.870	.005 *
Number of links	54.77	66.17	3.610	.070	9.470	.006 *
Number of levels	4.77	4.67	.820	.375	.266	.611

Table 2. Learning Outcomes for Students Blocked by Rank in School

6.3 Outcomes Related to Learning Styles

To evaluate whether hypermedia-based instruction affected the learning outcomes of preservice teachers with different levels of field independence/dependence, four dependent measures were examined for users blocked into four groups: first quartile (field independents - FI), second quartile (field independents mixed- FIM), third quartile (field dependents mixed - FDM), and fourth quartile (field dependents - FD). Two-factor ANOVAs with one within (pre and post) and one between (field independence/dependence) factor were used to analyze differences. Table 3 presents the results of the two-factor ANOVAs for the dependent variables: a) knowledge test, b) number of unique nodes on the concept maps, c) number of links on the concept maps, and d) number of levels on the concept maps. Results are included for the group (learning style) and outcome (pre/post) main effects.

Findings revealed no significant differences on learning outcomes using the hypermedia program that were related to differences in learning style depicted through field independence and field dependence. There were no significant main effects for the group variable. Significant pre-to-post differences were found for knowledge score (p =.0001), number of unique nodes on concept maps (p =.003), and number of links on concepts maps (p =.004). No significant difference was found for the fourth dependent variable, the number of levels contained in the concept maps (p. =.636).

Post-Scores	FD Mean	FDM Mean	FIM Mean	FI Mean	Learning Style *F*-Value	*p*	Pre/Post *F*-Value	p
Knowledge score	18.75	18.91	18.40	18.33	1.272	.312	152.850	<.001 *
Number of unique nodes	42.50	48.55	57.80	47.33	1.429	.265	11.521	.003 *
Number of links	50.50	59.00	64.20	52.00	1.000	.414	11.103	.004 *
Number of levels	6.50	4.36	4.80	3.67	2.364	.103	.232	.636

Table 3. Learning Outcomes for Students Blocked by Field Independence/Dependence

7 Audit Trail Analysis of Field Dependent and Field Independent Learners

The audit trail records of six students were examined for differences in usage patterns of the hypermedia program. Three students whose scores fell in the first quartile on available norms for the Group Embedded Figures Test were classified as field dependents (FD); three students whose scores fell in the fourth quartile were classified as field independents (FI) (Witkin et al, 1971).

7.1 Total Engagement Time

FI users spent 7.27 hours engaged in the two case studies compared to 7.19 hours for FD users. This difference was not statistically significant based on an unpaired t-test analysis (t = .-46, p = .96). These results indicate that users with different levels of field independence/dependence engaged in the hypermedia program an equivalent amount of time for learning.

7.2 Internal Jumps to Access Information

An analysis was done comparing the number of program choices selected in the final case study by gathering frequency data on button clicking. FI users made more selections with an average of 128 program selections compared to FD users who made an average of 91 selections. This difference was not statistically significant based on an unpaired t-test analysis (t = -.88, p =.429). These results indicate that users with different levels of field independence/dependence utilized options in the program with similar frequencies.

7.3 Proportional Engagement in Instructional Components

Table 4 displays the proportion of usage time the students engaged in the instructional components of the hypermedia program. Using an unpaired t-test analysis, differences between the FI and the FD users were not significant for seeking information and watching videos; but differences were highly significant for listening to experts and engagement in on-line problem-solving activities. Results indicated that users with different levels of field independence/dependence utilized the hypermedia program in different ways.

Instructional Component	Proportion of Time Mean for FD	Proportion of Time Mean for FI	*t* (4)	*p*
Seeking Procedural and Case Information	41.59	48.56	-2.015	.114
Watching Videos of Children	8.52	12.95	-1.359	.246
Listening to Expert Commentary	7.19	15.85	-8.038	.001 *
Doing On-line Problem-solving Activities	41.38	22.54	3.651	.021 *

Table 4. Proportion of Time Users Engaged in Instructional Components

7.4 On-line Quiz Scores

The on-line quiz scores for the case studies were averaged for each user based on the second-attempt score. Second attempts were used instead of first attempts because most users looked at the quiz before making a serious attempt to achieve the criterion score (80%) established by the instructor. FI users achieved an average of 76.7% compared to 73.3% for FD users. This difference was not significant based on an unpaired t-test analysis (t = -.447, p =.678). These results indicate that users with different levels of field independence/dependence demonstrated equivalent levels of achievement on the quizzes embedded within the hypermedia program.

7.5 On-line Problem-solving Reports

Two scores were derived from on-line reports written as a part of the problem-solving activities in the program. (1) A personal perspectives score rated responses to the on-line question prompts: *What is your perspective of this child's needs?* and *How do you support this position?* (2) A team synthesis score rated responses to the question prompts: *Who would you like to be on the team for this child?* and *What views do your team members share?*

Responses were scored by the two researchers using a holistic scoring rubric and differences were resolved prior to data analysis. On the *personal perspectives* comparison, no significant difference was found between users with different levels of field independence/dependence. Using a paired t-test analysis, the mean difference was 0.7 on a five-point scale ($t = -.417$; $p = .698$). Similarly, no significant difference was found on the *team synthesis* comparison between users with different levels of field independence/dependence. The mean difference was 0.33 on a five-point scale ($t = .25$; $p = .815$).

Similarity of scores indicated the users were equally successful in solving the case study simulations requiring them to develop personal perspectives toward children with behavioral problems, select therapeutic team members, and synthesize shared goals and beliefs across the team members.

8 Discussion

The findings from this study support the belief that hypermedia *is* good for instruction. College-age adult learners who utilized the extensive hypermedia environment demonstrated that they *could* and *would* customize their use of the program. Differences among the learners were documented by three variables—rank in school, prior experiences using computers, and learning style as expressed in field independence/dependence. Given the significant growth in knowledge as demonstrated on the pre/post knowledge test and the increased breadth and complexity of knowledge construction as demonstrated through the concept mapping procedure, it appears that the hypermedia learning environment provided equally effective instruction for learners regardless of their differences.

To examine how field dependent and field independent learners actually utilized the hypermedia program, audit trail records for six users were examined. Although these users spent equivalent amounts of time engaged in the program and demonstrated similar patterns of information access, significant differences were found in their choices within the instructional components of the program. Regardless of these usage differences, performance in on-line quizzes and problem-solving activities was similar.

In summary, users with differing learning profiles and usage patterns were equally successful in knowledge construction. These conclusions may be limited to a robust hypermedia intervention which is effectively integrated into an appropriate instructional program and conducted over a sufficiently long treatment period.

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JAVA CONCEPT MAPS FOR THE LEARNING WEB

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Abstract: Concept maps are graphical representations used for organizing and communicating knowledge. In conjunction with computer mediated communication, concept maps can be used to support distributed collaboration workgroups on the Internet and the World Wide Web (the *Web*). However, the diversity of computer platforms conforming the Internet makes desirable the implementation of portable applications to avoid discriminating computer platforms or overworking on diverging versions for multiple operating systems. This paper describes the implementation of jKSImapper and jKSImapplet, which are portable Java concept mapping tools used as instruments for supporting workgroup collaboration on the Internet and the Web.

1. INTRODUCTION.

The learning web [Norrie & Gaines 1995], was envisioned as part of a learning society where individuals are submerged in a life-lasting process of acquiring knowledge for coping with evolving environments. Individuals will not longer succeed in isolation or with a fixed amount of knowledge, but rather operate as part of integrated collaborative workgroups, where digital networks will be used for communication and collaboration [Shaw & Gaines 1996].

Under this scheme, tools are required for supporting the communication and sharing of knowledge, and for transmitting that knowledge to each member of a community. Computer mediated communication has been very effective in empowering human intelligence, resulting on the selection of digital computers and networks as the appropriate transmission media.

This paper will address the implementation of a portable concept mapping tool as a support for workgroup knowledge sharing on a learning environment, having the Internet as the transmission infrastructure, and Java as a viable solution for providing cross-platform execution of code among the diversity of computer architectures found on the Internet.

2. CONCEPT MAPS.

One of the mechanisms for organizing and communicating knowledge among individuals are concept maps [Gaines & Shaw 1995a]. Concept maps encompass a wide variety of diagrammatic knowledge representations. They can be defined as diagrams composed of links and nodes of different types. Concept maps can graphically represent and organize arguments and thoughts, thus providing an alternative to natural languages as a means to communicate knowledge.

[Fig. 1] shows a concept map constructed to visualize features found in the Java programming language. In this figure circular nodes were used to represent concepts, rectangular nodes to represent specific instances, and labeled arrows to represent relationships.

2.1. APPLICATIONS.

Concept maps have been applied on areas ranging from education [Novak & Gowin, 1984] and management [Axelrod 1976] to artificial intelligence [Quillian 1968] and knowledge acquisition [McNeese, Zaff, Peio, Snyder, Duncan & McFarren 1990]. Even when some of these disciplines may require specific constraints (also called *formalisms*) for interpreting and organizing information, the developments described on this paper do not enforce any of them.

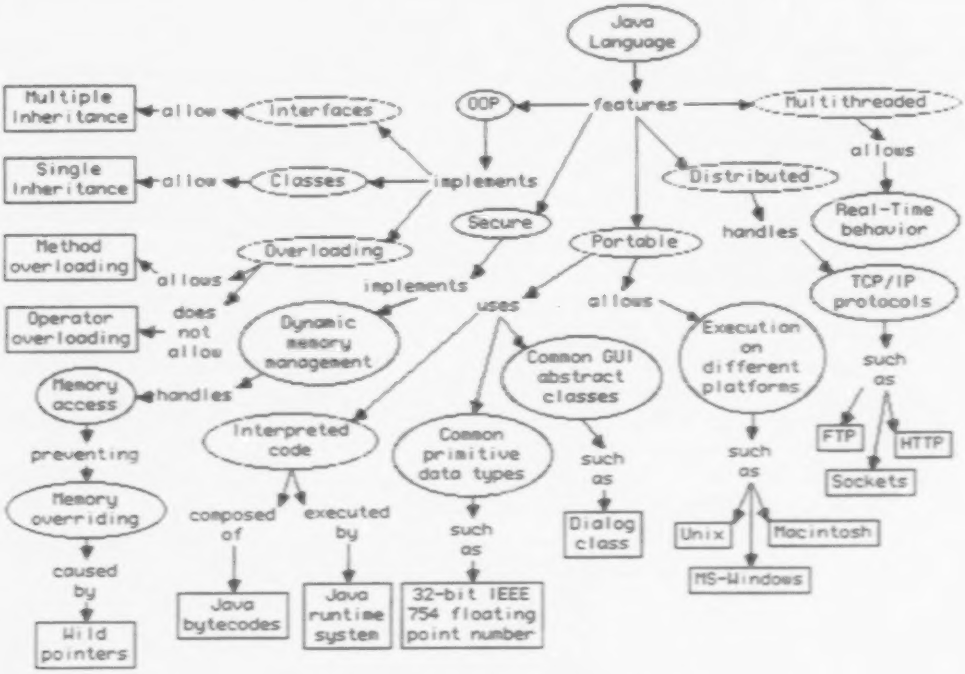
Java Language
features
OOP
Multithreaded
Interfaces
allow
Multiple Inheritance
Classes
allow
Single Inheritance
implements
Distributed
allows
Real-Time behavior
Secure
Overloading
allows
Method overloading
does not allow
Operator overloading
Portable
handles
TCP/IP protocols
implements
uses
allows
Dynamic memory management
Execution on different platforms
Common GUI abstract classes
such as
Memory access
handles
Interpreted code
Common primitive data types
such as
Dialog class
such as
FTP
HTTP
Sockets
preventing
Memory overriding
composed of
executed by
such as
Unix
Macintosh
MS-Windows
caused by
Wild pointers
Java bytecodes
Java runtime system
32-bit IEEE 754 floating point number

Figure 1: Concept map on the Java language.

Scenarios where concept maps can be used as a groupware tool include:

- ***Brainstorming:*** Where known concepts and relationships are suggested by individuals for conforming a meaningful workgroup knowledge structure.
- ***Decision making:*** Where current variables are identified on existent knowledge structures, leading to logical inferences that, ultimately, will help for decision making.
- ***Information navigation:*** Where concept maps are used as hypermedia organizers. In this case, information can be encapsulated on different levels of abstraction for easy comprehension, while allowing expansion to reveal details when required.
- ***Presentation planning:*** Where concept maps are used as tools for outlining content in a non-linear manner. This technique allows a quick interpretation of related material and their relationship with the subject of the presentation.

3. PORTABLE CONCEPT MAPPING TOOLS FOR THE INTERNET AND THE WORLD WIDE WEB.

While concept mapping systems are a valuable tool for the single user, their potential is fully achieved in multi-user environments. On such environments, concept mapping tools can provide a user interface to shared resources, and can support a range of group processes such as brainstorming and join development of knowledge structures [Kremer & Gaines 1994]. The use of a networking environment is required for supporting timely and geographically dispersed communities. From existing computer networks, the Internet presents the most suitable environment for multi-user applications, due to its wide extension and vast number of users. Additionally, hypermedia is supported on the Internet by the means of the World Wide Web.

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Previous developments at the Knowledge Science Institute have also addressed the need for supporting concept mapping tools on the Web. Such developments were successfully integrated as helper applications and Netscape plug-ins under the Macintosh, MS-Windows and Unix operating systems [Gaines & Shaw 1995b] [Kremer 1996] [Lapsley 1995]. Unfortunately, such tools implement dissimilar user interfaces, and often produce concept mapping data that is incompatible between computer platforms.

3.1. PORTABILITY.

The existence of many computer architectures integrated to the Internet demands a viable solution for cross-platform execution of code. In other words, programs need to be constructed with characteristics that allow their execution on many computer platforms, without modification. Programs with such ability are called portable or cross-platform.

Portable code can be classified into two categories depending on the transformation that the source code receives:

- ***Scripted code***: No transformation at all; source code is transmitted unmodified for the receptor to validate, interpret and execute. Known scripting programming languages on the Web include Tcl/Tk [Ousterhout 1994], JavaScript [Netscape 1995] and Python [van Rossum 1996].
- ***Intermediate code***: Source code is compiled, at development time, to a specific set of instructions "generalized" for execution on diverse computer architectures. The modified code will be interpreted when transmitted to receptors. The Java programming language [Sun 1996] is an example of intermediate code.

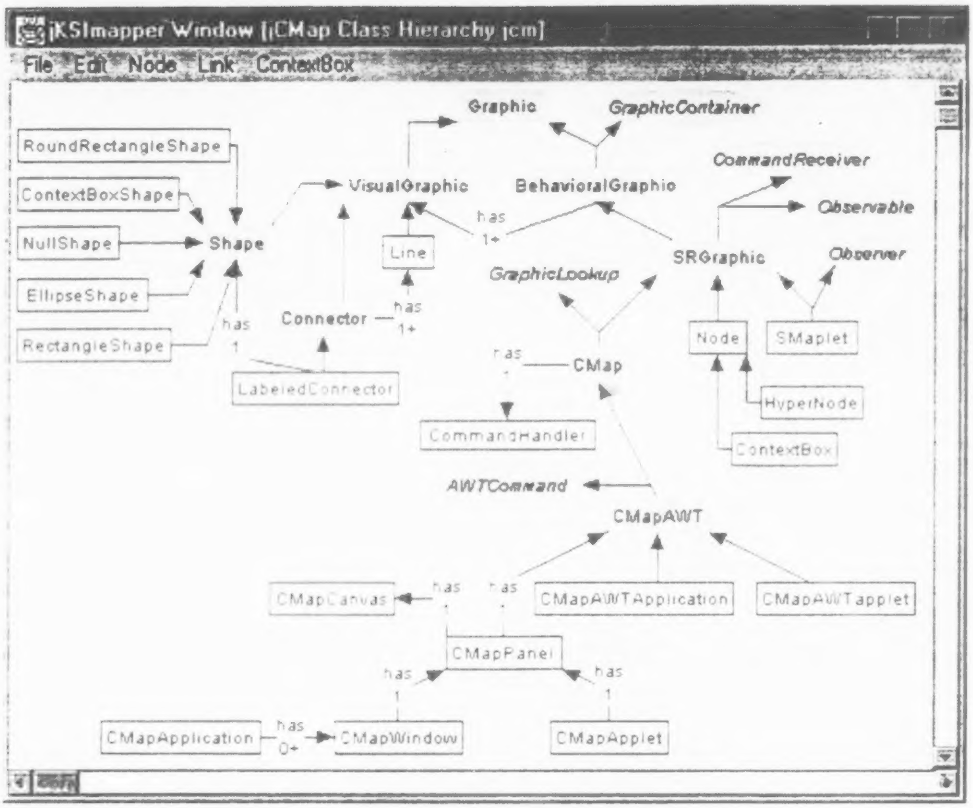
4. JKSIMAPPER AND JKSIMAPPLET.

jKSImapper and jKSImapplet are systems designed to support multi-user asynchronous concept mapping elicitation on the Internet and the World Wide Web. These systems were entirely implemented using the Java programming language, and were developed based on the Java *jCMap* class library. This library can be extended for implementing concept mapping systems that enforce formal knowledge constraints, such as Conceptual Graphs [Sowa, 1984].

4.1. THE JCMAP CLASS HIERARCHY.

Previous projects at the Knowledge Science Institute have produced a class hierarchy suitable for implementing an open-architecture concept mapping system. This class hierarchy, which is known as *CMap* [KSI 1996], was constructed using the C++ programming language. The aim of this hierarchy was to isolate the functionality of a concept mapping application from representations inherent to specific operating environments, thus improving source code portability.

[Fig. 2] shows the Java jCMap class hierarchy, which is derived from the CMap class hierarchy. This figure, which was created using jKSImapper, contains different visual elements for representing entities, inheritance and runtime relationships. Rectangular nodes were used to represent classes; ellipse nodes, for depicting interfaces; shaded nodes, for showing abstraction on classes and interfaces (which are abstract by default); and non-shaded nodes, for representing instanceable classes. Links also carry different meanings. Non-labeled links are used for representing inheritance, and labeled links are used for showing association between objects at runtime.


jKSImapper Window [jCMap Class Hierarchy jcm]
File Edit Node Link ContextBox
Graphic
GraphicContainer
RoundRectangleShape
CommandReceiver
ContextBoxShape
VisualGraphic
BehavioralGraphic
Observable
has
1+
NullShape
Shape
Line
SRGraphic
Observer
GraphicLookup
EllipseShape
has
has
Connector
1+
1
Node
SMaplet
RectangleShape
has
CMap
LabeledConnector
HyperNode
CommandHandler
ContextBox
AWTCommand
CMapAWT
has
has
CMapCanvas
CMapAWTApplication
CMapAWTapplet
CMapPanel
has
has
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1
CMapApplication
has
0+
CMapWindow
CMapApplet

Figure 2: Relevant classes from the jCMap class hierarchy.

4.2. RUNTIME SYSTEM ARCHITECTURE.

The systems described on this work were designed as client/server applications. jKSImapper and jKSImapplet perform as client programs that interact with a server process. While client systems are designed to perform as elicitation agents for constructing concept maps, server processes are planed as central coordinators of elicitation sessions and as data repositories.

4.2.1. CLIENT SYSTEMS.

Concept mapping client systems developed from the jCMap class library can be executed as Java applets or as Java standalone applications. As explained next, the differences between applets and applications are evident on the context of their use:

- Java applets are programs downloaded from remote servers and executed locally by Web browsers. This process is automatically performed each time an applet is encountered during Web navigation. The execution of Java applets requires browsers with a built-in Java Runtime Interpreter.
- Java applications are also programs, but they do not require the presence of a Web browser for downloading or execution. In that sense, Java applications are like any other regular standalone program that users may choose to install on their computer. Java applications require a Java Runtime Interpreter installed on the client computer.

[Fig. 3] shows a jKSImapper standalone application and a jKSImapplet applet running inside an instance of Netscape's Navigator. In this example, both programs collaborate for constructing a conceptual graph describing the sentence "No student read the book the teacher wrote," which is contained on a remote session maintained by a server process.

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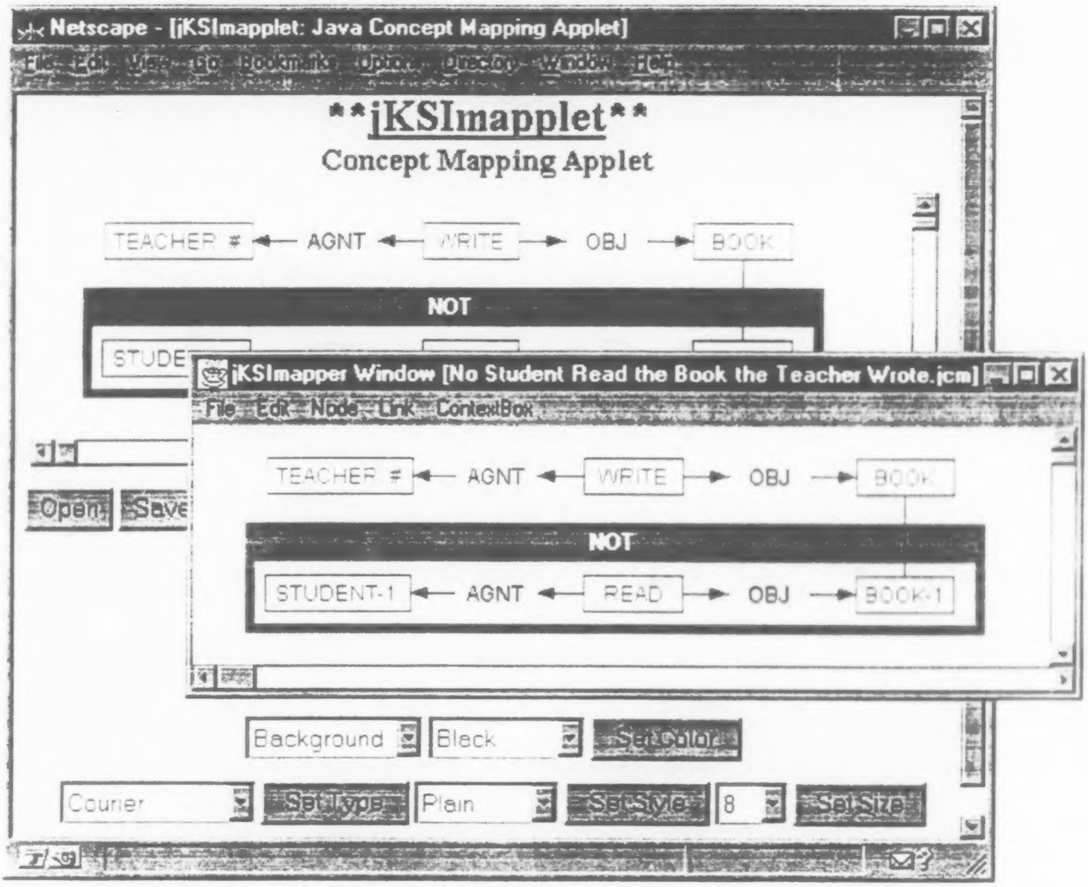
Netscape - [jKSImapplet: Java Concept Mapping Applet]
File Edit View Go Bookmarks Options Directory Window Help
jKSImapplet
Concept Mapping Applet
TEACHER # AGNT WRITE OBJ BOOK
NOT
STUDE
jKSImapper Window [No Student Read the Book the Teacher Wrote.jcm]
File Edit Node Link ContextBox
TEACHER # AGNT WRITE OBJ BOOK
NOT
STUDENT-1 AGNT READ OBJ BOOK-1
Open Save
Background Black SetColor
Courier SetType Plain SetStyle 8 SetSize

Figure 3: Groupware Concept Mapping Collaboration using jKSImapper and jKSImapplet.

jKSImapplet and jKSImapper are both aimed to the construction of concept maps. However, these programs hold slight differences on their implementation, specially on the user interface and the storage of data. jKSImapper implements menu options and can save concept mapping data either on the local disk or on remote servers. On the other hand, jKSImapplet does not implement menus and does not allow to save data locally. Applets do not implement menus since they do not own a window context (it belongs to the Web browser). Additionally, applets are not allowed to use certain client resources (such as secondary storage) due to security reasons. As shown on [Fig. 3], menus on jKSImapplet were replaced by widgets embedded on the Web document containing the applet. These widgets are designed to use JavaScript for triggering methods on jKSImapplet, thus effectively satisfying the need for menus. In the case of saving concept mapping data, jKSImapplet just allows storage on the server process to which it is connected.

4.2.2. SERVER PROCESS.

The jKSImapper Server is a process executed by server computers. This program has been designed to receive and maintain networking connections with client concept mapping programs, and to support multiple multi-user concept mapping elicitation sessions. Server processes are able to store concept mapping data on secondary storage.

Clients connected to a server process can send and receive commands generated as part of a concept mapping elicitation session. Such commands are stored by the server process on the history list of the session where the client is currently active. Commands are then broadcast to all the participants in the session (including the sender) for execution.

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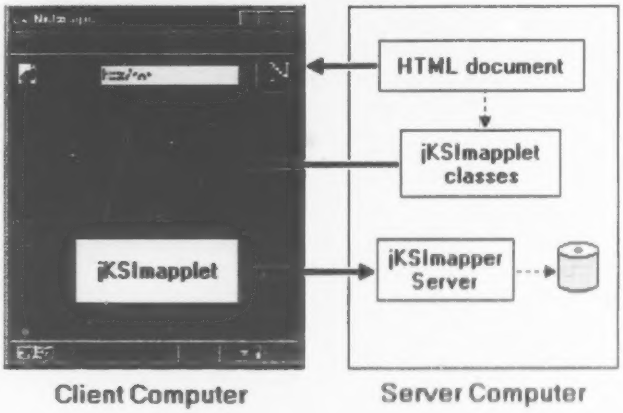
HTML document
jKSImapplet classes
jKSImapplet
jKSImapper Server
Client Computer
Server Computer

Figure 4: jKSImapplet Execution Structure.

[Fig. 4] and [Fig. 5] show the execution structure for jKSImapplet and jKSImapper, respectively. jKSImapplet is an applet that performs inside Web browsers. During Web navigation, browsers routinely download HTML documents containing links to hypermedia resources. In the case of jKSImapplet, when browsers detect the applet linked to a Web document, they will use their embedded Java interpreter for obtaining the corresponding classes from the server. Once downloaded, the classes will be used for executing the applet. After initialization, jKSImapplet will request a communication channel to the server for engaging on a multi-user concept mapping elicitation session. The applet will have access to secondary storage on the server for saving concept mapping data.

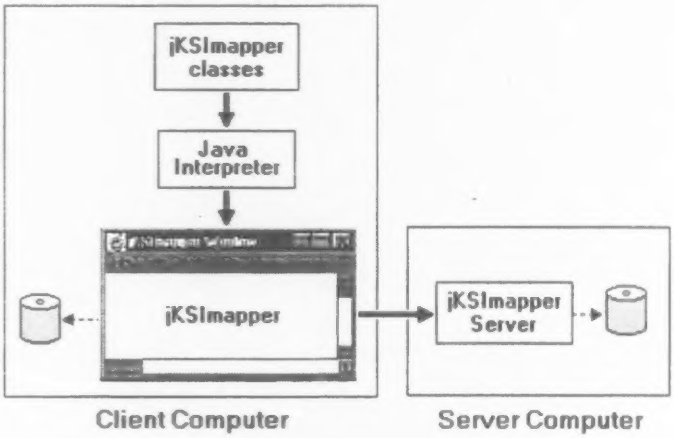
jKSImapper classes
Java Interpreter
jKSImapper
jKSImapper Server
Client Computer
Server Computer

Figure 5: jKSImapper Execution Structure.

On the other hand, jKSImapper is a standalone application. Differently from jKSImapplet, jKSimapper classes are located on the client computer, and they do not require a Web browser for execution. However, a Java interpreter is still needed for running the program. Once invoked, the interpreter will load and execute the classes corresponding to the program. After initialization, jKSImapper may or may not request a connection to a server process for engaging to a remote session. Such session can be shared with other jKSImapper and jKSImapplet programs. If a networking connection is not requested, jKSImapper will work on its own single-user elicitation session. jKSImapper applications can access disk storage on client and remote server computers.

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5. CONCLUSION.

Concept maps are a valuable tool for supporting visual thought processes. This characteristic has been reflected in the development of computer-based tools to represent concept maps graphically. The increasing availability of shared resources on the Internet and the Web, and the development of portable programming languages, such as Java, have opened new possibilities for distributed real-time collaboration. This paper has described the implementation of the jKSImapper and jKSImapplet multi-user concept mapping systems. These developments, which are fully operational as groupware tools for the Internet and the World Wide Web, can provide effective support for many significant conceptual processes in the learning web.

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Webmapping: Planning, Structuring and Delivering Courseware on the Internet

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Abstract: This paper reports on the development of Webmaker, a tool for the conceptualisation, structuring and delivery of educational materials via the world wide web (WWW). The paper identifies the need for the tool, describes its functionality and indicates its potential for further development.

1.0 The Need for Such a Tool

The increase in the use of the Internet not only as a repository of resources for learning but also as a means for the delivery of courses and specially prepared teaching material over the last two years is a particularly significant innovation in the range of educational provision. One site for example, that of the Internet University claims to list over 700 courses available over the internet [URL 1 1997]. Specialist courses which can no longer be supported by drawing on the student base in the traditional university catchment area can now be offered economically world wide[URL 2 1997]. But of equal significance is the way that the WWW is being incorporated into course provision within "conventional" campus based institutions. De Montfort University in the UK is typical in this regard. Various course elements are provided for student access via the WWW in a number of Faculties and major plans are underway to offer many more. These rapid developments have significant consequences:

- Faculty staff who are subject specialists in their own discipline area are becoming involved in web based delivery with little or no experience of developing materials for this medium;
- Faculty staff may find themselves working as part of a project team containing a range of specialists including courseware designers, programmers and graphics specialists. New and effective working relationships need to be developed so that the specific contribution of each member can be efficiently incorporated into the team as a whole;
- Materials developed for delivery via conventional printed means may be "repackaged" for delivery via the web with little or no adaptation of their structure for the changed medium.

But to produce successful web based courseware needs more than simply marking up existing material for use on the web; like all educational enterprises there is a need for careful planning and structuring. The collaborative process of courseware development also requires management tools - a need not yet addressed by most existing web creation tools.

2.0 Current Development Tools

A range of tools is now available to assist with courseware development and delivery. These are classified into three main groups below in order to indicate their relation to WebMaker.

Design and Mark-up tools such as HomePage (Claris) or Pagemill (Adobe) speed up the creation of web pages without the need to enter Hypertext Markup Language (HTML) code directly. However such packages primarily assist in the *design* of individual pages and do not assist with issues relating to the *structure* of the project as a whole. Webmaker is not designed to compete with such tools but to compliment them.

Assessment tools such as Questionmark[URL 3 1997] and FLAX [URL 4 1997] enable the incorporation of a wide range of assessment styles and methods into web based courses and this is of central importance in an educational context. Webmaker does not duplicate such functionality but facilitates its' appropriate incorporation within the structure of the courseware.

Web Courseware Management Systems can be broadly classified into two groups.

- WEST[URL 5 1997] for example, provide integrated solutions for courseware on the WWW by providing tutors with a mechanism for placing material, giving them a framework in which to produce certain forms of assessment activities, delivering e-mail based tuition and student monitoring and record keeping features. Students are provided with a complimentary environment in which they study the materials thereby providing a complete course delivery environment. Such systems have much to offer but they are primarily delivery vehicles rather than tools to assist in courseware creation.

- Other systems such as STILE [URL 6 1997] offer tools for the management of resources for teaching and learning. Staff can make available a wide range of resources which can be classified, searched and accessed in a variety of ways.

Recently Downes has cautioned against any over-reliance on complete management systems.
The really truly hard part to web-based course design is in content design. Any reasonably competent computer professional can provide chat facilities, threaded discussion lists, web pages, on-line registration, etc. But the core of on-line course materials will have to be determined by experts in the field working with experts in distance education delivery. [Downes, 1997]

We believe that this process can be facilitated through the use of tools such Webmaker.

3.0 The Importance of Concept Mapping

We have argued previously [Freeman and Ryan, 1995] that courseware is best developed in a team context, whereby individuals with a range of skills (subject experts, instructional designers, programmers) work together to agreed aims and objectives in the development of a project.

The development of powerful web authoring tools, and tools for the conversion of word processed documents into HTML format can tend to encourage the collapse of these various roles into one person - the universal courseware expert. When using such tools there is a tendency not to map out the courseware first, but in the act of marking up, to try to structure it at the same time. In effect, what happens is that the producer is both attempting to structure and plan the courseware and produce it simultaneously and in the process of so doing may lose sight of the main pedagogic and structures and navigational routes.

Courseware on the web may have a number of additional features not normally found in stand alone computer based packages. As well as the core sequence and structure of the material, whereby the user will proceed via a menu, next or previous buttons, clicking on an image map or some other navigational devices, typically it will contain hypertext links to other pages or to information held on other WWW sites. For example, definitions of terms, references, additional material or links. These may be explored by the student before returning to the main sequence of the courseware. These additional features mean that an overall planning and structuring of the educational project is critical in order to reduce the possibilities of the student becoming "lost in cyberspace" at worst or at best wasting time and effort following secondary links of little or marginal relevance. It is therefore important to spend time conceptualising the total project and considering what links (if any) have primacy.

Webmaker is a tool of two parts. The first part an icon based concept mapping tool, developed from previous tools we have used for the development of stand alone multimedia projects. It allows a subject expert working alone or, where appropriate, an instructional designer, to map out and plan the entire courseware project before that courseware is created. Using the system the developer may, via the manipulation of icons, try out the different links and routes, add and delete proposed sections and run through various sequences without being concerned about the actual delivery. This encourages the top level planning of the entire courseware prior to any attempt to construct it. The act of planning and structuring is therefore separated from the production. The second part of the tool is the Linker, which converts the map into HTML ready for use on the WWW.

3.1 Integrating Planning and Development

If a map of ideas alone were being provided, this could be done on paper or by using a commercially available package. Part of the planning process is to consider how the ideas mapped out will be realised and delivered via various media and how features of media can best be used for teaching purposes. Therefore, as part of the conceptualisation, it is necessary to specify how, for example, graphics, text, video or sound will be used and incorporated in to the delivery system.

At the mapping stage Webmaker provides a way of indicating the way in which media and content will be integrated within the final structure. This information developed at the concept mapping stage serves as a template for others to build and implement in the delivery system. Other parts of the package enable prototypes to be built and tested.

3.2 Team Roles

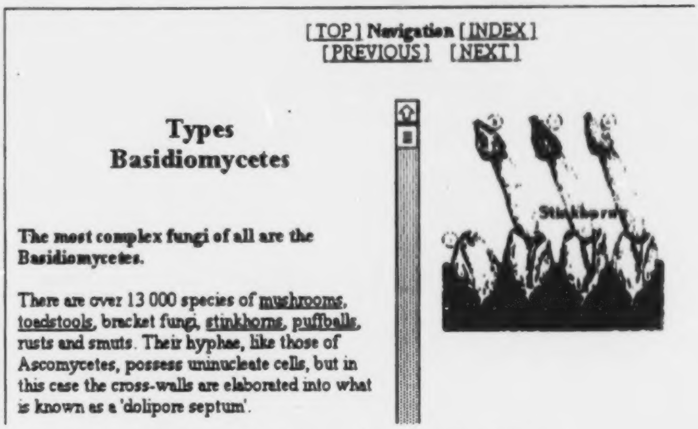
These tools provide ways in which each team member can clearly define their own role and at the same time locate that contribution within the overall structure. Because the concept mapping software and associated documentation is available to all course team members it greatly facilitates project management. For example, the graphic designer may examine the concept map to understand the context of a request by the map's author for an image.The designer can then supply an appropriate image rather than a generic one.

Most importantly this process is documented. At any time print-outs can be obtained showing the latest version of the map, details of all links plus any additional instructions or messages from one member of the team to another. In this way project planning and management are greatly facilitated.

4 Webmaker: an Overview

The application consists of two functional units each with several distinct parts:
- Knowledge structuring, which includes a concept mapping tool, a documentary library and a hierarchy builder,
- Preparation and production of HTML, which includes a resource linker, and an HTML generator.

To start we will describe the output from the application - the HTML file as seen by the end user in a WWW browser. [Figure 1] shows the browser view of an HTML output file. This is prior to any customisation in a web page design tool. Three frames are present. The top frame contains navigation information, particularly 'next' and 'previous' links; the left-hand frame contains text with embedded hypertext links, whilst the right-hand frame contains an image. Now consider the view at the concept mapping stage: [Figure 2]. Notice the sequence of four nodes - "phycomycetes", "ascomycetes", "basidiomycet" and "imperfecti".



[TOP] **Navigation** [INDEX]
[PREVIOUS] [NEXT]

Types
Basidiomycetes

The most complex fungi of all are the Basidiomycetes.

There are over 13 000 species of mushrooms, toadstools, bracket fungi, stinkhorns, puffballs, rusts and smuts. Their hyphae, like those of Ascomycetes, possess uninucleate cells, but in this case the cross-walls are elaborated into what is known as a 'dolipore septum'.

Figure 1: the browser view of an html output

By defining these four nodes as a sequence in the conceptmapping component, their relationship is maintained through to the WWW browser view. Note also that some of the text in the browser is active and results in the appearance of different images or other resources in the right-hand frame of the browser.

4.1 The Concept Map

The concept map begins as a blank window in which nodes are created, deleted, repositioned and linked. Figure 2 shows a small map. At this point the main concerns are the structure and relationships at the map level and the textual content of the nodes. Double-clicking on a node opens a node window into which text may be entered.

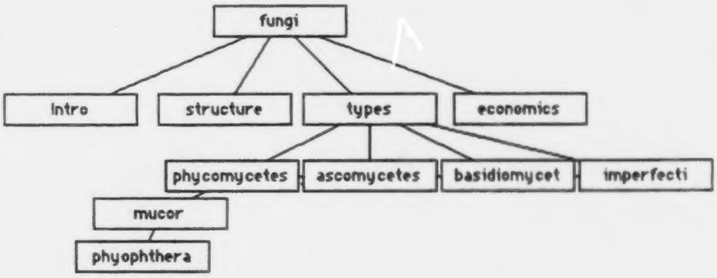


Figure 2: the concept mapping stage

Two processes occur here: text entry and the assignment of activity to a word or phrase in the text. Any word hilited and surrounded by square brackets indicates that a *description* exists for the type of activity or resource associated with it in the final WWW document. However, the resource is not produced at this point: it is produced later by other members of the team. Resources may of several types, such as a GIF, a sound (RealAudio or QuickTime), another node (i.e. another WWW document contained within the concept map or another WWW site), PDF document, JAVA applet, or Shockwave plug-in. The nature of the resource is passed on to the other team members through the documentation feature of the application.

4.1.1 Branching

In the map, [Figure 2], the node "phycomycetes" must be a branch node because there are more than two

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destinations from it. The hierarchy building component of the application is used to describe the branching structure of the subject domain described by the map.

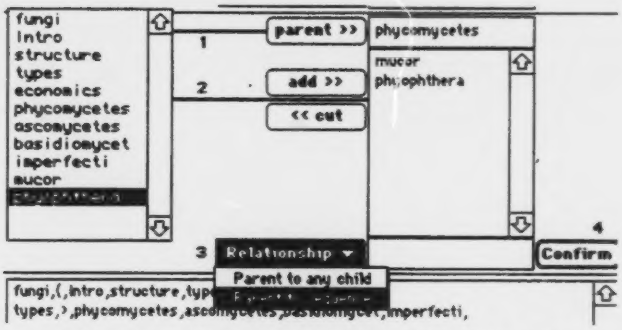

Figure 3: node hierarchy being built (part of image)

Figure 3 shows a hierarchy being built, in this case from the parent node "phycomycetes" to its siblings, "mucor" and "phytophthera". The relationship between the parent and siblings is identified at point 3, and the sequential nature of the linking is enforced by the navigational structure in the WWW page. Alternatively, the relationship "Parent to any child" might be selected. In this case the navigational space would include the names of all of the nodes, giving the user free choice.

4.1.2 Preparing the Map for the Web

So far the map consists of textual content and a branching structure: the GIF, FLAX, JAVA, RealAudio and other resources do not yet exist. An export from the map of all text and notes for resources is now passed to the graphic design members of the team so that requirements for resources may be stated within the context of the subject. The linkage of requirement to resource can be completed once the resources have been delivered, using the "Link Builder" window, [Figure 4]. Here active text such as the word "stinkhorns" is linked to a physical resource, the GIF image canis.GIF. Linkage can only occur if the resource is available. Similarly, the puffballs link is allocated to a WWW address.

The form of the browser window for this node is chosen using the controls at the bottom of the window. The browser may consist of a single window ("full") or a variation on a framed structure. Navigation information always appears in the top frame. The placement of the textual component is chosen by the radio buttons on the right.

4.2 Documentation from the Concept Map

A key aim was to provide tools not only to develop courseware but also to manage and document the process: The major documentation tools are described below.

- Notes are for annotation of the map and can be placed anywhere on it.
- The documentary window provides an overview of the entire process of development, recording saves, the number of nodes, node creation, deletion and linkage. It is in effect a history of the entire development.
- The node summary provides an overview of all the resource elements of each node such as text, graphics or hypertext links. Its main use is to provide an overview of the entire structure and can be exported to an ASCII file for incorporation into other project documentation, or printed out.

4.3 HTML Generation

Compilation to HTML takes less than 5 minutes even for very large or complex maps and has no visible component except for a dialogue box showing an indicator bar. The process will compile all fully-linked nodes.

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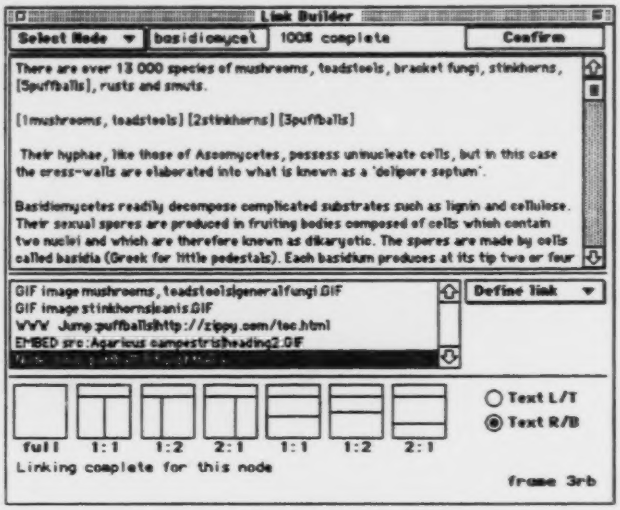
so even one node may be built if necessary. Error reporting is full, and is included within the documentation that is stored with the project. The compiled output from the editor is saved as HTML documents which vary in size from 120 bytes to 4Kb, depending on the complexity of the frame. These documents may then be further modified using any html editing tools or made available directly to students.



There are over 13 000 species of mushrooms, toadstools, bracket fungi, stinkhorns, [5puffballs], rusts and smuts.

[1mushrooms, toadstools] [2stinkhorns] [3puffballs]

Their hyphae, like those of Ascomycetes, possess uninucleate cells, but in this case the cross-walls are elaborated into what is known as a 'dolipore septum'.

Basidiomycetes readily decompose complicated substrates such as lignin and cellulose. Their sexual spores are produced in fruiting bodies composed of cells which contain two nuclei and which are therefore known as dikaryotic. The spores are made by cells called basidia (Greek for little pedestals). Each basidium produces at its tip two or four

GIF image mushrooms, toadstools|generalfungi.GIF
GIF image stinkhorns|canis.GIF
WWW Jump:puffballs|http://zippy.com/toc.html
EMBED src:Agaricus campestris|heading2.GIF

Linking complete for this node

Figure 4: the "Link Builder" window

One important component of this stage is the generation of a textual equivalent of the concept map. Rather than build a graphical representation in a web-browser window of what might be a very large map a decision was taken to use a familiar and easier structure - an indented contents listing. The contents listing may be edited so that spelling and case may be altered. A single click on a subject brings a sample of the text from that HTML document into the other frame of the browser. Another click takes the user to the full information.

Conclusion

The impact of the world wide web as a means of course delivery is now huge. Many academics are experimenting by putting up their courses on the web sometimes, by themselves or as part of a project team. It is essential that the entire courseware project is structured prior to development and that appropriate tools are available to assist in this process, and to provide detailed project planning and management support. Webmaker is a contribution to this need.

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A Repository-based Approach to Reuse of Educational System Resources

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Abstract: This paper describes a methodology for educational systems development, and the educational systems development environment called REBECCA. The methodology, which is based on information engineering, is used to support navigation for courseware development and educational system resources management. A repository-based approach is key to support of educational systems development and reuse of educational system resources such as application frameworks and components.

By the structure of the repository such as meta-model / model / object base and by use of object-oriented modeling, REBECCA is constructed for ease of reuse by systems analysts and subject matter experts. Systems analysts can build new models by reusing meta-models and models for their target system. Subject matter experts can develop their courseware by reusing models and object bases for their educational systems.

Introduction

Educational systems based on instructional design theory [Merrill 1987; Gagné 1993; Tennyson & Breuer 1993] are becoming a major interest. Systems such as ID Expert [Merrill 1987], IDE [Russell et al. 1988], GAIDA [Gagné 1993] and CREAM [Nkambou et al. 1996] have been developed by instructional design automation. These systems provide a set of tools to be used in the instructional process. However, these systems do not have a mechanism for reuse of educational system resources such as application frameworks and pedagogy components. These systems are constructed mainly for reuse of instructional units and for curriculum conception.

Software reuse, a subject of long-standing interest, has recently emerged in a new, business-critical guise. Software reuse is effective to achieve the goal of a software organization, which is to build useful working software systems in time and within given economic constraints. In particular, application frameworks and components based on object-oriented technology are the main reusable elements in reuse projects such as REBOOT [Karlsson 1995].

We have developed two kinds of application frameworks, AVALON [Fuji et al. 1994] for the individual learning environment and CAMELOT [Fuji et al. 1995b; Fuji et al. 1996] for the collaborative learning environment. These application frameworks are built by use of object-oriented technology, and are stored in the REBECCA repository system [Fuji et al. 1995a] for reuse. Repository-based methodology is derived from information engineering [Martin 1989] and instructional design theory.

The purpose of this paper is to present the methodology and development environment (which is called REBECCA) for a systems analyst and a subject matter expert according to the object-oriented repository approach. For a systems analyst, REBECCA enables the reconstruction of educational systems by reusing application frameworks such as AVALON and CAMELOT. For a subject matter expert, REBECCA provides a means of course navigation, the reuse of pedagogies and instructional units, and target system generation.

This paper is organized into three sections. Section 2 outlines the methodology. Section 3 introduces the basic concepts of REBECCA. Section 4 describes the architecture of REBECCA.

Methodology for Educational Systems Development with Repository

In software engineering, structured techniques are applied to one project, whereas in information engineering, structured techniques are applied to the enterprise as a whole or to a large sector of the enterprise. Information engineering techniques encompass those of software engineering in a modified form [Martin 1989]. Information engineering has been defined with reference to automated techniques as follows: an interlocking set of automated techniques in which enterprise models, data models and process models are built up in a repository and are used to create and maintain data-processing systems. The repository is one of key technologies in information engineering, and it steadily accumulates information relating to the planning, analysis, design, construction and, later, the maintenance of systems.

The field of instructional design was initiated by the United States Department of Defense during World War II to improve the efficiency of certain types of high-level technical training programs such as pilot training [Reiser, 1987]. The systems approach is a step-by-step procedure for solving problems. It has been applied to educational problems at all levels, from education as a whole, to training for a specific target population. In instructional design, the systems approach is sometimes referred to as instructional systems development (ISD). There are numerous models of this approach. Although the models differ in detail, such as the number and sequence of steps or the way in which specific components are grouped, the steps are grouped into the following five categories: analysis, design, production, implementation, and evaluation.

The methodology of REBECCA (Repository-based Environment for Computerized Courseware Analysis) is based those of information engineering and instructional design. The characteristics of this methodology are as follows.

- Object-oriented repository for managing educational system resources
- Reuse for educational systems framework
  (individual learning environment / collaborative learning environment)
- Reuse for educational systems components
  (instructional object / pedagogy object)
- Instructional objects for individual adaptive learning
  (multimedia object / knowledge object)
- Navigation for courseware development (analysis, design, construction)

The Basic Concepts of REBECCA

Managing Educational System Resources

Educational system resources are stored in the repository and reused through the repository. The major functions of educational system resource management are as follows.

Conceptual modeling

This function is used by systems analysts. When an educational system is to be developed, educational systems frameworks such as AVALON and CAMELOT are used to create a skeleton of an educational system. Systems analysts modify the skeleton by reusing frameworks, and REBECCA supports a construction of a conceptual model using the object modeling technique [Rumbaugh et al.1991]. As a meta-model, an object model is used.

Consistency management

Educational system resources in the repository are necessary to keep consistency for the object. If systems analysts modify the frameworks using symbols which are not defined in the meta-model, the system checks the consistency between the meta-model and the frameworks.

Browsing repository

By means of the browsing function, the user can view the contents of the repository. Systems analysts can view the structure of the repository, and subject matter experts can view the reusable frameworks and components.

Supporting the Function for Educational Systems Development

Navigation for courseware development

The steps of educational systems development are analysis, design, and construction. Subject matter experts define the learning environment, and specify a learning goal and theme in the analysis phase. In the design phase, they specify reusable educational resources, such as pedagogy object and instructional object. They can locate the reusable resources by using the thesaurus. In the construction phase, they produce the instructional object which cannot be reused, and finally, the system generates the target educational system required by the subject matter expert. The system navigates these procedures based on the methodology. Figure 1 shows the process flow of educational systems development for the subject matter expert.

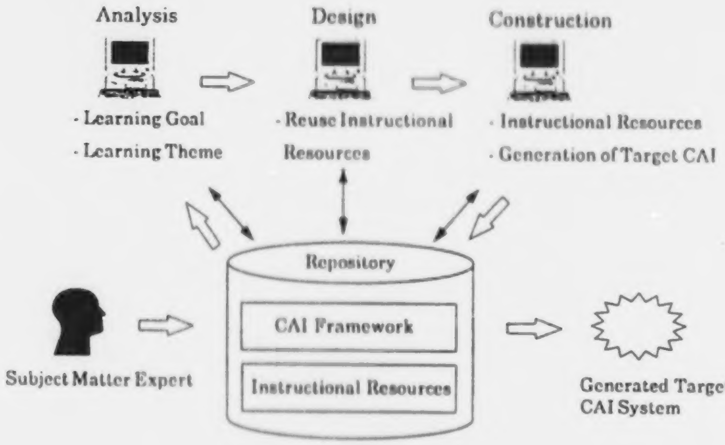
Analysis
Design
Construction
- Learning Goal
- Learning Theme
- Reuse Instructional Resources
- Instructional Resources
- Generation of Target CAI
Repository
CAI Framework
Instructional Resources
Subject Matter Expert
Generated Target CAI System

Figure 1: The process flow of REBECCA

Designing the course

The subject matter expert can reuse the curriculum stored in the repository, and add new themes or delete unnecessary themes. At the same time, he or she can retrieve instructional objects related to the theme by using the thesaurus. This thesaurus has been developed for information systems education in universities.

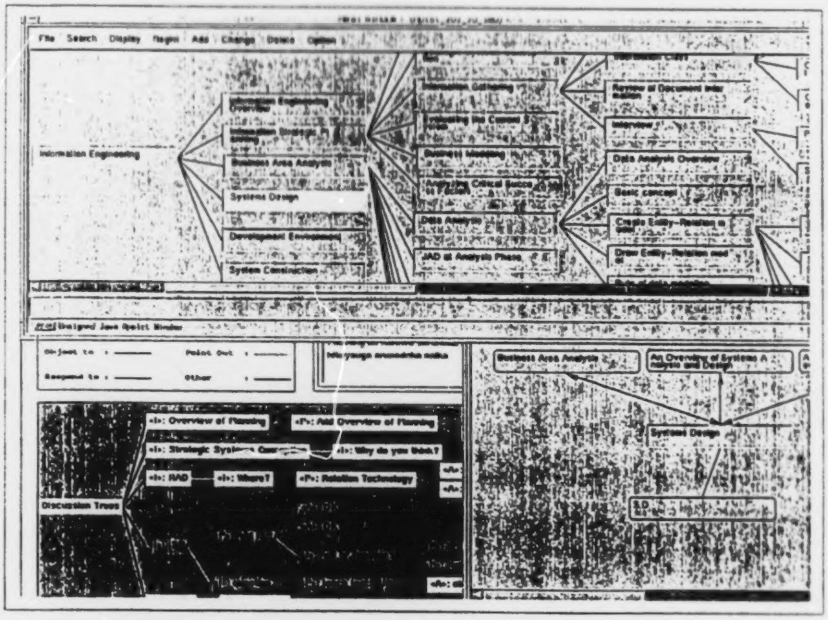
File
Search
Display
Region
Add
Change
Delete
Option
Information Engineering
Business Area Analysis
Systems Design
System Construction
Data Analysis
Data Analysis Overview
Basic concept
Discussion Trees
Systems Design

Figure 2: Sample screen for designing a curriculum

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Designing the curriculum with collaboration

In defining the curriculum, especially in new domains such as information systems education, collaboration is useful. REBECCA supports collaborative work on the Internet using a discussion model in order to define a new curriculum. Using the WWW, subject matter experts from various countries can define a curriculum while sharing ideas. The defined curriculum database is stored in a WWW Server. Figure 2 shows a sample screen for designing a curriculum.

Architecture of REBECCA

Structure of Repository

A repository is a place for storing all the information required in a software engineering environment, for example tools, software products and documents. The PCTE, Portable Common Tool Environment, is a standard for a public tool interface for an open repository [Wakeman & Jowett 1993]. However a meta-model of the PCTE is defined by extended Entity-Relationship modeling and is not defined encapsulation. The meta-model of REBECCA is defined by an object model.

CDIF, the Case Data Interchange Format, has been developed to define the structure and content of a transfer that may be used to exchange data between two CASE tools. CDIF uses models to define the information content of transfer. Several layers of model are used; the second being an abstraction of the first, the third of the second, and so on [CDIF Technical Committee 1994]. The structure of a repository is based on the CDIF architecture. The repository of REBECCA is composed of three levels. Figure 3 shows the structure and functionality of the repository.

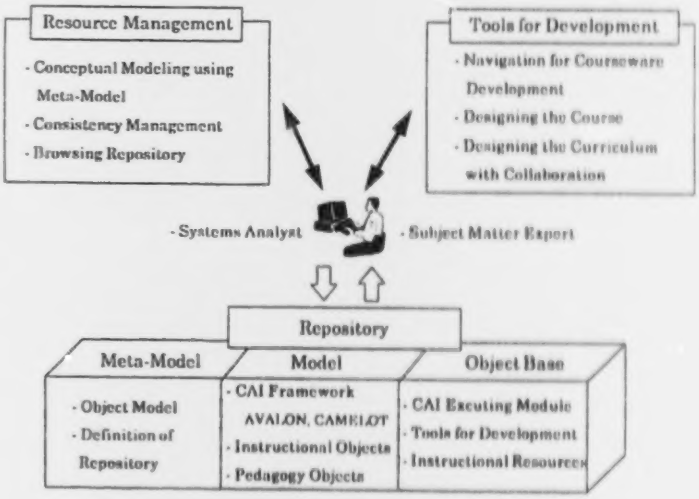
Resource Management
- Conceptual Modeling using Meta-Model
- Consistency Management
- Browsing Repository
Tools for Development
- Navigation for Courseware Development
- Designing the Course
- Designing the Curriculum with Collaboration
- Systems Analyst
- Subject Matter Expert
Repository
Meta-Model
- Object Model
- Definition of Repository
Model
- CAI Framework AVALON, CAMELOT
- Instructional Objects
- Pedagogy Objects
Object Base
- CAI Excuting Module
- Tools for Development
- Instructional Resources

Figure 3: Structure and functionality of the repository

Level 1: Meta-model

The first level holds a model of about level 2, i.e. a model about the model describing the resources at level 3. Models about models are commonly called meta-models. The semantic content of the meta-model is defined using notations of object modeling techniques, such as class, association, generalization, aggregation. This meta-model also self-describes the repository.

Level 2: Model

The second level in the repository is the conceptual model defined using the meta-model. Frameworks and components are described in the model. AVALON, the framework for an individual learning environment, functions as a multimedia intelligent tutoring system. CAMELOT is the framework for the collaborative learning environment. The instructional object and pedagogy object are components that can be reused.

Level 3: Object Base

The third level in the repository is the implemented objects based on the level 2 model. There are executable educational systems, development tools, and instructional resources.

A Framework for Educational Systems

The reuse approach relies on the concept of reusable software components produced and stored in a repository. There are two main types of object-oriented components: solution-based inheritance hierarchies and domain-based frameworks [Karlson 1995]. This framework is based on domain-based frameworks such as educational systems. The educational systems frameworks used are AVALON for the individual learning environment and CAMELOT for collaborative learning.

AVALON

The AVALON educational system framework is a multimedia intelligent tutoring system. The system provides adaptive instructional units and pedagogy suited to the learners' understanding. The system also provides multimedia instructional units, such as video, voice, text, and image data, suited to the learners' characteristics.

CAMELOT

The CAMELOT educational system framework is a collaborative learning support system. The learning process is based on a nominal group technique. The system facilitates collaborative learning navigation, group discussion, and remedy of collaborative work solutions. The pedagogy is a combination of rule-based reasoning and case-based reasoning.

Components for Educational Systems Development

Instructional object

An instructional object is an extended instructional unit. An instructional object is composed of a multimedia object and a knowledge object. A multimedia object incorporates multimedia instructional material, such as text, image, voice, and video. A knowledge object incorporates the knowledge representation of instructional units, such as semantic network, rule-based reasoning, and case-based reasoning. An instructional object is used for components when subject matter experts design courseware.

Pedagogy object

The basic concept of the pedagogy object is based on Gagné's accumulated learning model [Gagné 1985]. Pedagogy objects are composed of "problem solving", "rule learning", "concept learning", "multiple discrimination learning", "verbal association", "chaining", "stimulus-response learning", and "signal learning". Subject matter experts can design their pedagogy for educational systems by combining these pedagogy objects.

Conclusions

In this paper, I have described a methodology for educational systems development, and the educational systems development environment called REBECCA. The repository approach is key to supporting educational systems development and reusing educational system resources such as application frameworks and components. Using three-level structure, such as meta-model/model/object base, and using object-oriented modeling, REBECCA is constructed for ease of reuse for systems analysts and subject matter experts.

In line with the widespread use of the Internet, I believe that the reuse of educational resources on the Internet is becoming an important technical issue. The project is currently addressing the subsequent phase of a distributed developing environment with CORBA.

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Institutional Transformation to a Learning Web

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Abstract: It is recognized that increasing costs and the convergence of computer and communications technologies are creating pressures on universities to transform their modes of operation to be more appropriate to modern society. This article analyzes the transformation of educational institutions from a *learning web* perspective, detailing the critical drivers, obstacles and resources for transformation, and proposing some specific modes of operation for a networked higher educational system. It concludes with a section on how the learning web may be implemented by increasing the flexibility and reducing the cost of university administration through electronic commerce systems.

1 Transforming Educational Institutions

In their influential study on *Transforming Higher Education* for the Society for College and University Planning (SCUP), Dolence and Norris (1995) note that:

> *The Information Age is an epoch where "higher education" could occupy the pivotal role in society. It is a time when demand for learning is anticipated to skyrocket, but resources available under existing models for educational delivery are expected to remain fairly static. Fresh vision is needed to create new delivery systems for learning, new paradigms for financing, and new models for higher education.*

The vision of a *learning web* has been proposed as a model for a future learning society in which individuals, organizations, computational agents and services, and other resources are linked through digital networks to function in a variety of self-organizing, goal-directed systems (Norrie and Gaines, 1995b). Experiments in the application of the learning web to undergraduate collaborative learning have been reported (Shaw and Gaines, 1996), as have the development of special-purpose tools supporting the learning processes in the web (Gaines and Shaw, 1995; Shaw and Gaines, 1995).

An article at EdMedia'96 addressed the rationale for, and systemic foundations of, the learning web, its implications for restructuring the higher education system, and the role of information technology in supporting that restructuring (Gaines, Norrie and Shaw, 1996). This article analyzes the transformation of educational institutions from a learning web perspective, detailing the critical drivers, obstacles and resources for transformation, and proposing some specific modes of operation for a networked higher educational system.

2 The Dynamics of Transformation

In analyzing social change one specifies the initial conditions, the expected outcomes, the critical drivers for change, the expected obstacles to change, and then considers the implementation of change in the light of these factors. Figure 1 diagrams this analysis for the higher educational system.

The initial conditions are that our current universities are a historically well-funded, growing system, taken for granted by society, but their mode of operation is labor-intensive and based on intellectual craft skills. The drivers for change are the inability of society to sustain the present funding model (Clotfelter, Ehrenberg, Getz and Siegfried, 1991; Clotfelter, 1996), and the convergence of computer and communications to a low-cost ubiquitous 'information utility' (Martin, 1978; Gaines, 1996). The obstacles to change are our existing cultures based on 30-200 years of existing concepts of a university, the cost of funding the transition, and the limitations of existing technologies.

An expected outcome is a networked world-wide university system integrated into all aspects of everyday life which will support time- and distance-independent life-long learning (Rossman, 1992; Harasim, Hiltz, Teles and Turoff, 1995). The logic behind this predicted outcome will emerge as we consider the resources required to implement changes that will make universities more cost-effective in fulfilling their roles in society.

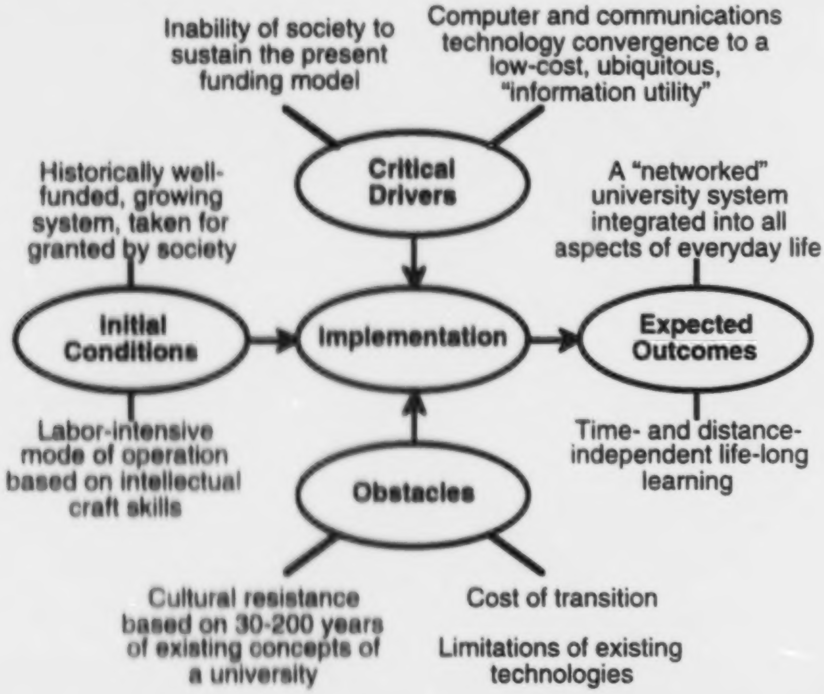
Inability of society to sustain the present funding model
Computer and communications technology convergence to a low-cost, ubiquitous, "information utility"
Critical Drivers
Historically well-funded, growing system, taken for granted by society
A "networked" university system integrated into all aspects of everyday life
Initial Conditions
Implementation
Expected Outcomes
Labor-intensive mode of operation based on intellectual craft skills
Obstacles
Time- and distance-independent life-long learning
Cultural resistance based on 30-200 years of existing concepts of a university
Cost of transition
Limitations of existing technologies

Figure 1 Factors in the transition to a post-modern university system

I have used the much-abused term "post-modern" to describe the networked university because of its connotations of a post-industrial, post-regimented, post-authoritarian age, where people at large recognize that human meaning and human culture are human inventions that are their choice and their responsibility (Aronowitz and Giroux, 1991; Lyotard, 1992). The authority of the academy is being undermined now in the post-modern enlightenment in the same way that the authority of the church was undermined 300 years ago in the modern enlightenment (Schmidt, 1996). Universities cannot stand aside from society as the ultimate conservators, guardians and disseminators of knowledge. They have to become an integral part of a world community where digital communications and media are becoming commonplace, and the students of North America will converse with the people of France or Japan or Russia across the Internet as readily as they chat to their neighbors.

3 The Resources for Transformation

If universities are to transform, both the outcome and the dynamics of transformation are critically dependent on the resource structure that supports them. Figure 2 presents a graphical analysis of the major resources involved. At the center is the definition of the institutional mission. It may seem strange to treat this as a resource, but the existence of a well-defined mission statement, accepted by all the major participants is a key resource in managing change. It is salutary to read Newman's introduction in 1852 to his Dublin lectures on *The Idea of a University*, and recognize that in every age the idea of a university has been brought into question (Turner, 1996). Newman states:

> *The view taken of a University in these Discourses is the following:- That it is a place of* teaching *universal* knowledge. *This implies that its object is, on the one hand, intellectual, not moral; and, on the other, that it is the diffusion and extension of knowledge rather than the advancement. If its objects were scientific and philosophical discovery, I do not see why a University should have students; if religious training, I do not see how it can be the seat of literature and science."*

If one took out the adjective "religious" qualifying training, then this statement of a century and a half ago could be seen as a contribution to the current debates on the roles of the university in research, teaching and training.

Underlying most mission statements is the notion of the university as a *community of scholarship*, where scholarship is some form of open, critical inquiry expressed as overt knowledge. Newman's notion of universal knowledge is suspect in a post-modern world where all knowledge is seen as a human construct subject to a variety of human biases. However, universality does not imply absolutism, and the objective of universality in the sense of being shareable throughout a world-wide community is still at the heart of the notion of scholarship. Landow (1996) in his essay on *Newman and the Idea of an Electronic University* emphasizes the support of collegiality possible through electronic networks, "an idea more honored in the breach than in the observance" in our existing physical institutions.

The mission of the university system as a whole may be defined in terms of a community of scholarship, but the mission statements of particular universities have to go beyond this in defining their particular intended contributions to that community. In the past, a particular physical location could be a major component of the mission—many universities were formed to serve their local communities on the assumption that it was most cost-effective for students to enroll at a university close to their homes. That assumption is now coming into question as digital communications support the possibility of a virtual university, accessed electronically rather than physically. However, the idealized notion of a community of scholars does not address all the reasons why a student might wish to attend a university. University education is only one component of the life experience of individuals and many other factors may determine the attractiveness of a particular university. Those other factors need to be made explicit in a mission statement. In addition, there may be aspects of the scholarly experience in terms of involvement in human society and culture that the technology does not yet support well, and those aspects need to be made explicit in a mission statement if the role of the technology is to be properly evaluable. Overall, in times of change, it becomes very important to be explicit, comprehensive and correct in defining the institutional mission.

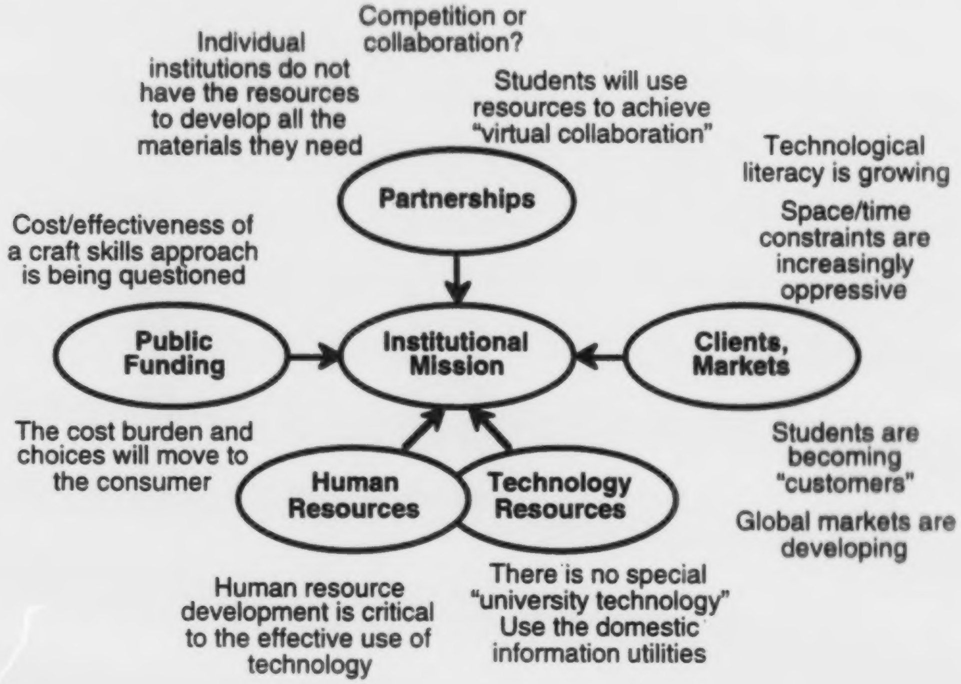
Competition or collaboration?
Individual institutions do not have the resources to develop all the materials they need
Students will use resources to achieve "virtual collaboration"
Technological literacy is growing
Space/time constraints are increasingly oppressive
Partnerships
Cost/effectiveness of a craft skills approach is being questioned
Public Funding
Institutional Mission
Clients, Markets
The cost burden and choices will move to the consumer
Students are becoming "customers"
Global markets are developing
Human Resources
Technology Resources
Human resource development is critical to the effective use of technology
There is no special "university technology" Use the domestic information utilities

Figure 2 Resources involved in the transition

On the left of Figure 2 are the resources supplied to universities through the general social levies of public funding. These resources are reducing because the cost-effectiveness of universities is seen as suspect, and a free market economy in which resources are allocated according to value received is seen as more appropriate. On the right, resources from this free market are shown where students as customers are increasingly technologically literate and find the space and time constraints of having to attend a particular location at a prescribed time increasingly oppressive. In addition, the true clients who provide the funding may be the employers of the students, making workplace education significant, and global markets are developing for higher education services world-wide.

The internal resources for change are still in large part people—as much, if not greater, effort needs to be put into developing human resources as into technical ones. The provision of technology resources is becoming increasingly simple as domestic information utilities gain the high speed multimedia and discourse support facilities necessary for effective knowledge dissemination. If universities need to develop a specialist 'technology' of their own it is at the intellectual level of facilitating learning through the effective use of the commonly available information technologies.

The most significant resource issue is that shown at the top of Figure 2, the development of *partnerships* because individual institutions do not have the resources to develop all the materials they need. One response to the availability of distance-independent higher education may be to compete in the physical territories of other universities, and in the short-term this is happening for expensive professional qualifications. However, in the longer term those competing in this way will find their positions eroded as other institutions join the competition and drive prices down so that the distance education market becomes fragmented and financially less attractive. The natural economic model is one of virtual collaboration through market differentiation in which different institutions specialize in the provision of different higher educational services. Students will take course modules from different institutions and be accredited for their qualifications by other institutions that may specialize in accreditation and management of the learning process rather than content provision.

It is these considerations that lead to the expected outcome of a *networked university system integrated into all aspects of everyday life* as shown on the right of Figure 1. They do not lead to a monolithic model in which all higher education is in the cyberspace of a completely virtual university. People have an existence in the physical world also, and different university locations, their amenities and cultures will still be relevant to where students reside. It is an intrinsic feature of the growth of lifelong learning that more students will be concerned about the location of their employment also, but with tele-commuting a growing trend the decision as to whether to telecommute for ones education or ones employment, or both, will be an increasingly open option. The "network" will not be purely electronic but will involve the heterogeneous integration of learning experiences in the physical classroom, workplace, and virtual campuses of many educational institutions.

4 Learning Web Administration through Electronic Commerce

The pedagogical principles underlying the implementation of the learning web have already been analyzed (Norrie and Gaines, 1995a; Gaines et al., 1996) and exemplars given (Gaines and Shaw, 1996; Shaw and Gaines, 1996; Herlea, Shaw and Gaines, 1997; Shaw and Gaines, 1997). They stem from the basic concept of a learning society as an autopoietic system recursively structured as a network of intelligent learning agents, with the agents ranging from major social complexes and institutions through to roles in individuals (Gaines, 1994). The emphasis on structured social networks leads to pedagogical principles that facilitate the formation of social learning environments where students are resources for one another and where instructors are more facilitators than lecturers.

However, the development of networked higher education resources raises as many administrative issues as it does pedagogical ones. Implementing a distributed social learning environment involves the management of a heterogeneous mixture of resources from many sources. In terms of existing systems it may be seen as requiring the *modularization* of courses to generate a wide range of *virtual courses* tailored to learner needs. The use of modules from various sources to constitute an accreditable virtual course is educationally attractive in providing greater variety for students with different learning styles. It also makes it easier for faculty to specialize in the provision of modules in which they have specialist knowledge both of content and appropriate learning environments and teaching styles.

The administration of virtual courses within a virtual university presents major problems. Universities already have a cumbersome and expensive bureaucracy to deal with the administrative and financial transactions of large numbers of students taking individual mixes of courses on different time scales. Some aspects of administration, such as room allocation and class scheduling will become much simpler for time- and distance-independent learning. However, the current system is complex already in coping with the charging for courses and in the allocation of the resulting resources to the units responsible for courses. Modularization and outsourcing of course modules will increase the administrative complexity by an order of magnitude and require new systems for charging for comparatively small transactions with a low overhead in transaction costs.

This is precisely the problem being addressed by new developments in electronic commerce where customers shop in electronic malls on the Internet and the entire transaction from product browsing, through ordering and payment, to delivery is automated. The efficiency of the banks EDI systems is now such that transactions resulting in payments of less than $1 can now be carried out cost-effectively. A good example is MIX, the ManGlobe International eXchange (http://www.manglobe.com/index2.htm) which provides the backend services for retailers offering products on the web in collaboration with the Royal Bank of Canada.

A MIX retailer pays the cost of operating a web site together with a transaction fee of 5% with a maximum of $10 to ManGlobe for taking care of the administrative and financial aspects of the transaction including credit clearance, inventory management, delivery tracking and payment. An additional 1.5% is levied if ManGlobe handles a credit card transaction on behalf of the retailer. The ManGlobe technology is designed to ensure transaction security through the issue of confidential identifiers to customers that control access to their financial sources.

This model is directly applicable to the provision of learning modules as retail products through the web. It provides for the comparatively small financial transactions involved with a low administrative overhead and detailed tracking. Inventory management is relevant where modules have an associated human component such as email access to an instructor and it is important to control the numbers of students enrolled at the same time. The secure transaction technology provides the beginnings of a system for checking that a student being assessed is the one actually registered for the module, although that is a more complex problem than ensuring the security of a financial transaction.

An electronic commerce model of a higher education shopping mall may not seem attractive, or appropriate, to many academics, but it takes care of the administrative operation of a university that most of them do not perceive. From a pedagogical perspective, the issue will be one of developing educational modules that can be delivered effectively through the various means available, not only the web, but also through classes, seminars, self-study modules not on the web, and so on. The overall learning environment will be one of *team teaching* with the team extending to colleagues at a range of other institutions. It is often said that the administrative aspects of a university are a major influence in stifling innovation in the exploration of new teaching techniques and learning environments. The provision of a highly flexible and cost-effective administrative system through electronic commerce techniques could remove the major impediments to innovations in teaching and learning.

5 Conclusions

It is recognized that increasing costs and the convergence of computer and communications technologies are creating pressures on universities to transform their modes of operation to be more appropriate to modern society. This article has analyzed the transformation of educational institutions from a learning web perspective, detailing the critical drivers, obstacles and resources for transformation, and proposing some specific modes of operation for a networked higher educational system. It has suggested how the learning web may be implemented by increasing the flexibility and reducing the cost of university administration through electronic commerce systems.

The transformation of universities into a world-wide networked higher educational system that is responsive to the needs of post-modern society and the opportunities offered by the convergence of information technologies requires changes in many aspects of the operation of the university, not only in the teaching methodologies and learning environments but also in the adminstrative infrastructure. None of these changes affects the university system's fundamental role in society in supporting a community of scholarship providing open, critical inquiry into all aspects of our existence. The changes are in the way in which that role is carried out and in the opening of the community to transcend physical and other boundaries. The task of the scholar today is to preserve the integrity of the scholarly process while taking full advantages of technologies which extend the collegial domain to any person in any location world-wide.

Acknowledgments

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HyperClinic:
Cooperative Hypermedia System for Medical Education

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Abstract: This paper presents HYPERCLINIC, a cooperative hypermedia system to support medical students with diagnostic learning and the planning of cardiologic therapeutic procedures. HYPERCLINIC provides an integrated environment for patient record manipulation, including images, sounds and graphics. The system has facilities for individual and group learning as well as desktop conferences between cardiologists physicians and students in Intranet environments.
The system was implemented at the Cardiology and Cardiovascular Surgery Unit of UFBA/Fundação Bahiana de Cardiologia in cooperation with the Department of Computer Science of COPPE/UFRJ.

1. Introduction

Medical practice is an essentially cooperative activity. Due to the constantly increasing complexity of the tasks to be accomplished, the association of physicians to find more efficient solutions to health problems becomes more and more important. In university and specialized hospitals, such cooperation plays a vital role in the formation of a good health care professional.
Besides that, medicine increasingly leans upon technological resources which are broadly applied, both in teaching and in the medical practice, influencing either directly or indirectly the health service professional's work. Within this context, research is developing hypermedia cooperative systems [Ng et al. 93], [Kleinholz & Ohly 94], [Cheng et al. 95] to support cooperation among physicians involved in situations in which information sharing is important. Examples are the process of diagnosis or when you have to decide for the procedure which has to be applied in a particular case.
HYPERCLINIC is a cooperative hypermedia system designed to the medical education of cardiologists. Its main purpose is to support medical sessions where medical students and specialists interact in order to analyze complex clinical cases. The clinical session works as a class in which the students exercise their diagnosis ability through the analysis of problems related to the field of study.
The HYPERCLINIC system has been developed and evaluated at the Cardiology and Cardiovascular Surgery Unit (UCCV) of UFBa's Professor Edgar Santos University Hospital in association with Bahia's Cardiology Foundation (FBC) and the Department of Computer Science of COPPE-Federal University of Rio de Janeiro.

2. Medical Education

Conventional medical instruction faces several problems related to the changes in the educational process involving social aspects that affect the classroom culture, the concept of continuous education and technological questions. Barnett [Barnett 95] lists some of these problems:

- the poor emphasis that medicine colleges place on the importance of continuous education;
- the difficulty with knowledge maintenance due to the information explosion relative to the amount and complexity of the new scientific knowledge, which is vital to medical science, and also to the fast pace at which new ailment diagnosis and treatment methods are developing;
- the use of an educational strategy for the transmission of medical knowledge that is eminently passive, the student being left in such a position that he/she is merely a receptor, which is not suitable to medical instruction;
- the difficult integration of the theoretical material learned during the first years of academic life into the clinical training given at the end of the medical course. Moreover, the syllabuses of the various subjects sometimes lack integration with each other, making it hard to approach the solutions to practical clinical problems coherently.

The solution to those problems depend on changes to be made both in the curricula and in the priorities of medical schools. As a result, information technology can be seen as a long term solution. As computer science is incorporated in the educational process, bringing along mechanisms to simplify, discipline and improve the expression of reasoning, the quality of educational models, strategies and contents also improves, fitting education for the new reality of a modern world [Campos 94]. In recent years, there has been significant progress in the development of new medical educational systems, such as simulators [Woolf & Hall 95], tutorials [Lee et al. 94], [Pavel 95], conferencing systems [Ng et al. 93], [Kleinholz & Ohly 94] and systems designed for the study of medical cases [Kaltenbach 94], [Cheng et al. 95].

2.1 Learner-Centered Education

The new, learner-centered approach is based upon the idea that people learn best when they are concerned with the subject in question, because they feel motivated to search for a new understanding and develop skills so as to be able to solve real problems. The focus of attention lies on the student's *needs*, *abilities*, and *interests*. This kind of teaching-learning process usually appears in association with a problem-solving approach, the problems being chosen so as to meet the students needs. The major goal is to center the instruction in a set of realistic, intrinsically motivating problems [Norman & Spohrer 96], [Soloway & Pryor 96]. Hence, the active exploration and build-up of learning are strongly stimulated.

In the core of such changes lie the new technologies, which appear as powerful tools that allow the application of several construtivist ideas [Schank et al. 95], [Norman & Spohrer 96].

2.2 Hypermedia Systems

Hypermedia systems have a great potential of applicability in training and education in both scientific and non-scientific fields [Nielsen 90]. Whenever multimedia technology is inserted in an adequate educational context it inspires active learning by favoring an exploratory attitude towards the subject of study. The information is presented in a concrete form that is easy to grasp. Moreover, it provides the student with constant feedback, allowing him to take part in the instructional process.

The kind of information used by health care professionals in the treatment of a patient are essentially multimedia [Kleinholz & Ohly 94], [Dayhoff 93], [Ip et al. 93]. The information backing a diagnosis comes from different sources and appears in different forms, such as reports, graphs, diagrams, references to books, handwritten notes, films, video tape sequences, audio tapes and conversations with patients and colleagues [Kleinnholz & Ohly 94]. Therefore, much of clinical investigation and medical diagnosis relies on the interpretation of visual data [Ratib 93], [Klingler et al. 92].

In Cardiology, the interpretation of images, charts and sounds is crucial in an adequate therapeutical guidance. A computerized educational system to be used in the study of clinical cases, capable of integrating such information and using the hypermedia resources in a unique environment adds a significant contribution to the learning process. Furthermore, if the project of the educational software joins together multimedia resources and other technologies, such as artificial intelligence [Woolf & Hall 95] and cooperative work, it is capable of supporting a high quality, effective learning.

2.3 Computer-Supported Cooperative Work

Since the learning process involves the evaluation of facts, principles or procedures, the definition and solving of problems, and creativity, students need interpersonal communication along with the opportunity to question, defend and discuss matters. Therefore, the educational process can be regarded as a social rather than an individual activity [Bates 94].

The explosive growth of computer networks, mainly after the popularization of Internet and the WWW (World Wide Web) technology, greatly increased the possibilities to spread computer-supported cooperative activities.

Medicine is a natural area of application for distributed, collaborative multimedia systems. Hypermedia conferencing systems are particularly attractive to promote the cooperation among physicians [Ng et al. 93]. The use of conferencing tools, integrated with the applications which access and handle the patients data, results in a faster, more precise diagnosis, increases the information availability, and brings forth new opportunities to consult specialists [Kleinholz & Ohly 94].

3. The Cardiology Clinical Session

The purpose of the Cardiology Clinical Session at UCCV/FBC is to help the medical students to develop the ability to make the interpretation of clinical cases of different pathologies. The study of cases involves the handling of information from the patient's record, made up of text, graphs, images and video tapes.

In the course of the session, real clinical cases involving patients admitted to the university hospital are discussed by cardiologists, resident physicians and students. This meeting defines the therapeutic procedure to be applied in each case.

During the medical session, resident physicians deepen and set in their knowledge. It also gives them an opportunity to express their opinions on real, complex cases and come to final decisions, thus improving their interpretative capabilities. To the students, the session offers the opportunity to get a better knowledge of the specialties of cardiology and the diagnosis techniques applied in this field, as well as to see how the theoretical concepts learned throughout the medical course work in practice.

There are specific stages in the clinical session, ranging from the selection of the case to be discussed up to the final decision about the therapeutic method to follow. The stages are described bellow:

a) Selecting case, information gathering and organization of the data: Because of its educational character, the clinical session begins with the presentation of cases by the students, under the supervision of physicians. The physicians select the more interesting cases, which are either emergencies or current complications in the clinical situation. Resident physicians, along with the students, gather and organize the information and then present the summary of the case, according with the due clinical methods .

b) Review of the cases and students preparation: A few days before the session, a student gives his colleagues and supervising physician a preview, so as to consolidate his presentation and review the relevant points concerning the case. The physician leads the group in the interpretation of the results obtained in medical examinations and eventually discusses the therapeutic procedure to be applied and makes suggestions for further reading.

c) Presentation of cases: When the clinical session begins, clinical and interventionist cardiologists, Cardiology residents, medical students, heart and thorax surgeons, and perhaps some invited professors, are present. The meeting is coordinated by the head of the Cardiology and Cardiovascular Surgery Unit.

Every case is presented by a student and by those physicians who represent the sub-units which made the examinations involving images, such as the echocardiogram and the catheterism.

After the presentation, the session coordinator begins the discussion, asking the intern who is responsible for the case to present a summary of it, as well as a suggested therapeutical conduct that he/she will justify. Afterwards, the physicians argue the case, demonstrate weak points and define the therapeutic procedure that is to be applied. The coordinator arises discussions and collate competing opinions so as to show the possibilities and shortcomings of the treatment options. References to the medical literature and to well established cardiology standards can be used to justify opinions. At the end of the discussion, the coordinator summarizes the therapeutical conduct to be followed.

4. Hyperclinic System

Taking the approach of learner-centered teaching as a basis, an active learning environment to be used in medical studies has been designed which supports the study of clinical cases in Cardiology, as well as the basic research and the interaction among the students.

The HYPERCLINIC system allows students in different stages of knowledge to view complex cases and to interact with instructors, physicians and other colleagues. The system's assumption is that the discussions and the access to clinical and bibliographical data should make it easier for the student to design a diagnosis and to define therapeutical procedures. In doing so, the student learns through exploration, stimulating the development of creativeness and mental organization in the construction of knowledge.

HYPERCLINIC shows characteristics of computer supported cooperative work and includes the highly desirable possibility of cooperation among the students accomplished through the information exchange, group study and the supervision of a preceptor. The system is available through the Intranet in several sites at the Cardiology and Cardiovascular Surgery Unit, making the access and the interaction among users very easy. Thus, each student may study at a different place, whenever it is more convenient to him at his own pace. He can redo the tasks as many times as necessary and interacting with colleagues and/or instructors any time he wants.

Such a program uses tools which support the process of organizing, preparing an presenting the selected cases for the clinical sessions. It also keeps a database that keeps records of all the cases already studied for further reference so that cases with similar pathologies can be checked out for similar solutions. Moreover, it can access bibliographical and tutorial cardiology databases designed at UCCV/FBC [Pavel 95], [Aragón et al. 95].

The system can also enlarge the clinical session objectives, introducing a further stage of study that allow cardiologists and students to follow a continuous education program. Such program uses the possibility to access the cases through the Web network or through a CD-ROM, including the video of the session debate, which shows the procedure followed to determine the adequate therapeutical conduct.

4.1 System Architecture

The Hyperclinic system makes use of the Web Architecture. The user's workstation, running a Web browser and plug-ins for multimedia data, accesses a local Web Server, which offers a number of options for patient case study or inclusion of new cases. Common Gateway Interfaces (CGI) programs on the Web Server access the Database Server to generate Hypertext Markup Language (HTML) documents [Fig. 1].

Hyperclinic has three distinct environments: Authoring, Study, and Presentation Environment.

a) Authoring Environment: This environment gathers the clinical cases. Firstly, forms which contain the information related to the patient must be filled in. The conventional data, images and video sequences from examinations are captured or recovered from other systems to build up the patient's case. All the pieces of information concerning the patient are stored in a multimedia database.

b) Study Environment: Using a WWW browser the students analyze the cases, having the chance to do research, add notes, make diagnosis, give suggestions of therapeutic procedures, and interact with instructors and colleagues.

c) Presentation Environment: This module allows the visualization of clinical cases, serving as an integrated means of presentation to be used during the session. It replaces all other audiovisual media, such as the overhead projector and the VCR. The conclusions drawn from each case in the session are included for further study.

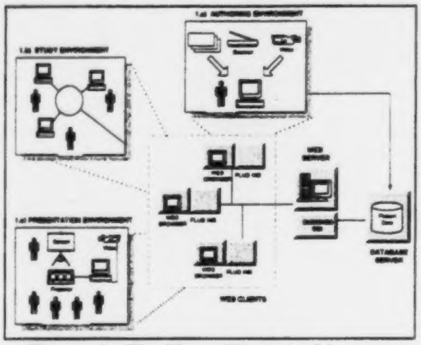

Figure 1 - The HyperClinic Architecture

4.2 Cooperation Mechanisms

Amongst the various possibilities of mechanisms to support both synchronous and asynchronous communication and cooperation those which could contribute to the achievement of the systems objectives have been selected. The list given bellow describes such mechanisms and the way in which their incorporation to Hyperclinic have been accomplished.

Group structuring by definition of roles and related privileges in the manipulation of clinical cases. The roles and privileges which have been defined in the system are:

- Student - is allowed to examine the clinical cases, make research, add notes, suggest diagnosis and therapeutic procedures and includes questions in the List of Doubts;
- Preceptor - responsible for students tuition; checks out what students have already studied a particular patient's case, whether they have added a comment or not and what their doubts are, if there is any. He is also allowed to add entries to the glossary of terms and answers to questions appearing in the List of Doubts;
- Physician - examine the cases, gives opinions on the cases and answers questions appearing in the List of Doubts;
- Technical Administrator - manages the list of system users (includes, deletes or changes user's data), defines privileges, includes data concerning new cases and updates system information, such as dates of events, the medical sessions schedule, messages, etc.

Aid to the generation of ideas and use of the community suggestion board. Hyperclinic system has the following mechanisms:

- List of Doubts - a session containing the most commonly asked questions of students and the answers given by the physicians and/or the preceptor;
- Bulletin Board - may be used to display a number of varied pieces of information, such as calls for academic works presentation, notices about conferences, meetings, lectures, etc.

Support to several types of communication (both formal and informal):

- Electronic mail;
- On-line conferencing - a site for discussions where physicians, preceptors and students can interact simultaneously, exchange information about the cases and cooperate to define a joint diagnosis or therapeutic procedure suited for a particular case.

Mechanism to make the "presence" of the group members at a given time more apparent. In the literature this is referred to as "group consciousness".

- List of Active Users - displays a list showing all the users that are connected to the system at that time.

4.3 Study and Research Mechanisms

Support of the information access, through "navigation" instruments and structured queries accomplished by the browser itself or provided by the application.

- Aid to navigation - the student can have an overview of the case under study, so as to determine which parts of the document have already been examined. This prevents the student to get "lost" within the hyperdocument;
- Selection of cases based upon a list of attributes (e.g.: the patient's name, diagnosis, date of clinical session, etc.);
- Functions performed by Web browsers: printing of documents, inclusion of notes, bookmarks, etc.

Support to research:

- Glossary of Medical Terms, specific for Cardiology - this glossary can be changed by physicians and instructors, who can add more information to it;
- Access to tutorials specifically designed to deal with subjects related to Cardiology.

5. Conclusions

This paper presents the HYPERCLINIC, a system designed to support the teaching/learning process in Cardiology, using a learner-centered, case-based approach. The system offers an environment suitable for the preparation, study and presentation of cardiology clinical sessions, providing tools to accomplish group study and the sharing of multimedia information.

With the aid of this system, students can interact more frequently with colleagues and instructors and the clinical cases can be studied in a more structured way, taking advantage of the hypermedia environment. Due to students cooperation, the learning process becomes easier and the rate of transmission of knowledge increases.

The prospects for the future include the access to the system through the Internet. Students could then accomplish broader research works, accessing bibliographical bases distributed by the net and taking part in discussion forums and conferences. A further goal is to add mechanisms to support teleconferencing, so that physicians of other hospitals could be virtual participants in the clinical session, thus allowing the creation of multicenter groups of study.

A running prototype has been developed which uses an Intranet environment to achieve easy of use and future transparency between Intranet and Internet environments.

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Cooperative Learning: Students As IT Experts And Resource Personnel In The Classrooms

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Abstract: This paper reports on how pre-planned, structured cooperative learning activities centered around the computer and the Internet are used to effect interaction and solve some of the teaching-learning problems in the classrooms of Malaysian secondary schools. Specifically, these activities have been structured with the at-risk students playing the lead role of IT experts who work closely with the teachers and their groupmates to source for useful materials for teaching-learning activities in the classroom. Preliminary findings from the study have found that such interesting learning experiences with CD-ROM multimedia reference materials and the Internet, plus the prestigious role as IT experts and resource personnel in the classroom, have had very positive effect on the at-risk students.

Introduction

Since the early days of computer-based instruction (CBI) there has always been an emphasis on individualized instruction which focuses on self-pacing and the prescription of instructional methods and materials according to learner individual goals and needs. The rationale for individualization in computer-based instruction is so appealing that most computer-based learning materials have been designed for that purpose. However, despite the emphasis on matching instruction to individual learners, in reality, students often have to work at the computers in small groups, simply because most schools are unable to provide one-to-one computing facility.

Research in cooperative learning in the last two decades has consistently pointed to important instructional and affective benefits. With regard to CBI, in addition to improving achievement, cooperative learning methods may actually provide a cost-efficient way of using the computers. For example, if students were to work in groups of two or more, hardware costs can be reduced by at least 50%! More importantly, cooperative learning that focuses on interaction may also be a solution to the problem of social isolation associated with individual CBI activities. [Rysavy & Sales 1991] reviewed research in recent years on the use of the cooperative learning structure with computer-based instruction. They concluded that cooperation at the computer can produce some very positive results.

With the renewed interest in small-group learning in recent years, all forms of small-group work have come to be labeled as "cooperative learning". It is, therefore, not surprising that small-group work at the computers is also often erroneously referred to as cooperative learning. [Hooper 1992] cautioned that simply grouping students without shaping the environment may stimulate few cognitive or affective benefits. This is because positive learning outcomes from cooperative learning are contingent upon effective student interaction which is influenced by factors such as task structure, rewards, group dynamics, and interpersonal skills. As pointed out by [Cohen 1991], to optimize the benefits of cooperative learning, attention must be focused on the design of cooperative learning materials and activities.

The following is a brief description of a study that is being carried out to see how cooperative learning activities centered around the computer and the Internet can be organized to effect interaction and solve some of the teaching-learning problems in Malaysian secondary schools. This effort is a follow-up to earlier studies in Malaysia on cooperative learning. The earliest exploratory study indicates that cooperative learning is an effective teaching-learning approach that is congruent with the National Education Philosophy and the objectives of the Secondary School Integrated Curriculum [Gan 1992]. Subsequent studies on courseware development for cooperative learning have also produced very positive findings pertaining to achievement and the learning of higher-order thinking skills among students [Gan 1994][Gan 1995].

Objective of the Study

The main objective of the study is to use pre-planned structured cooperative learning activities which are centered around the computer and the Internet to effect interaction and solve some of the teaching-learning problems in the classrooms of Malaysian secondary schools. One of the problems in Malaysian classrooms is the large class size of forty or more students which makes it impossible for teachers to give sufficient personal attention to students, even those who are in dire need of it, such as the at-risk students. The other problem is the heavy teaching load of teachers which leaves them little time to source for interesting instructional materials or ideas to augment the standard prescribed text books.

Research Method

With regard to the two problems mentioned earlier, this study focuses on providing at-risk students - who need more individual attention from the teacher - the opportunity to work more closely with their teachers, and to play a leading role in learning activities in the classroom. This is achieved by training and appointing them to be the IT experts in small heterogeneous cooperative learning groups in the classrooms. These groups are given the task of sourcing for instructional and reading materials related to subject topics pre-determined by their teachers with the help of the researcher. The resources are obtained either from CD-ROM references or from the Internet. Thus, this is an activity that involves students in a more contributive role in the instructional process in the classroom, while at the same time presents a way of lessening teachers' work load in the sourcing of materials.

The at-risk students, who have been trained at the beginning of the school year in the use of CD-ROM references and the Internet, are in fact the group leaders who perform the following tasks: consult with their teachers on a regular basis what materials to source for, search and source for materials with the assistance of their groupmates who play the roles of language consultant, artist and editor; as well as train them in the use of CD-ROMs and the Internet. To effect such role specification in accordance with one of the principles of cooperative learning, each group consists of one at-risk student (the IT expert), one high-ability student proficient in English (language consultant), and two other students of average ability (artist and editor).

The IT expert sources for materials, gets the help of the language consultant in translating the materials from English to Bahasa Malaysia (the medium of instruction in Malaysian schools), and works with the artist and the editor to format and compile the materials. The materials can then be used by the teachers for incorporation into learning activities in the classroom. Over one school year, each of the ten groups of students (in a class of forty students) works on an average of one such project per month. Since the sourcing and compilation activities are done out of class, and IT facilities - which are confined to either the library or the computer lab - are limited and shared by the whole school, this frequency and arrangement have been found to be most ideal.

A Summary of the Research Procedure

1. Identification of at-risk students in two science classes (Grades 7, 9 or 11) in each of the two co-ed schools participating in the case study.
2. Collection of data pertaining to the profile of these at-risk students from records over the years.
3. Assigning all students in each class to heterogeneous groups.
4. Identification of topics and assigning of topics to groups.
5. IT training for the teachers.

6. IT training for at-risk students.
7. Collection of data pertaining to relevant achievement scores of all students in the previous school year.
8. Teacher observation, anecdotal reports while project is on-going.
9. Collection of data pertaining to relevant achievement scores of all students during the school year.
10. Comparison of students' pre- and post-project achievement scores and profile data, compilation of teachers' observations and anecdotal records.

IT Training for Teachers and Students

The training sessions for both the teachers and students include the following topics:

1) Introduction to the Internet
2) How to use e-mail, WWW, gopher, and telnet
3) Introduction to some educational sites
4) How to use search engines to search for information
5) Hands-on sessions on e-mail and WWW
6) How to retrieve and print information culled from the Internet
6) Introduction to various educational CD-ROM titles
7) How to retrieve and print information culled from the CD-ROMs

The Task Structure of IT-Based Cooperative Learning Activity

[Johnson & Johnson 1989] outlined five necessary components for effective cooperative learning: individual accountability, positive interdependence, promotive interaction, collaborative skills, and group processing. Based on his extensive review of classroom research on the achievement effects of cooperative learning, [Slavin 1990] concluded that cooperative learning methods can be an effective means of increasing student achievement, but only if they incorporate group goals and individual accountability. Learning activities in the classroom must therefore try to incorporate these components into their task structure to effect learning through productive interaction. IT-based group learning where students are simply placed in groups to work on an unstructured project at the computer, as is currently being practised in most classrooms, is unlikely to produce benefits.

A major premise in the design of this project is that it can produce the desirable learning outcomes when used as part of a carefully planned year-long instructional activity that is coordinated by a teacher. The following is an account of how the components of cooperative learning are incorporated into the task structure of the learning activity currently under study:

1) Individual accountability

To ensure individual accountability, all group members are required to master the materials they have sourced. One strategy suggested to the teachers is that a test on content be given to all students at the end of specified periods over the year. Individual reward is then given based on the average score of all group members. Based on the findings from their research on cooperative computer-based instruction, [Yeuh & Alessi 1988] suggested that this form of individual accountability be emphasized to create a feeling of fairness among all group members. [Rysavy & Sales 1991] also emphasized the importance of assigning each student a specific role in a cooperative learning group. To meet this requirement, each learning group incorporates four well-defined roles as mentioned earlier.

2) Positive interdependence

The strategy mentioned above of rewarding individual based on group's average score also ensures positive interdependence. This is supported by the IT-based activity which assigns a specific role to each student. Each student has to use his/her expertise to help his/her group come out with the product. Another strategy is giving group rewards based on group performance. [Yeuh & Alessi 1988] also suggested that group goal be provided in the form of a group reward so as to motivate everyone to work together. In this study, one of the group rewards is that if any group's presentation material is judged by the teacher and other classmates as good, it is put on the school's homepage and the researcher's homepage of educational resources for educators. In this way, the resource materials produced by the students' effort can be shared with the education community nationwide, and this makes them feel that their effort is being rewarded and recognized.

3) Primitive interaction

The series of tests, the assignment of different roles and tasks to different students in the group, and the reward system based on group average score, all encourage primitive interaction. The activity that involves translation work also provides weaker students (especially the at-risk students) the opportunity of getting help from the "language experts", and to better understand information culled from the various CD-ROM references and the Internet.

4 & 5) Collaborative skills and Group Processing

These are the skills that are pre-requisites to the successful use of cooperative learning activities. As such, teachers are encouraged and constantly reminded to allocate time for reinforcing collaborative skills and focusing on group processing whenever there is an opportunity.

Preliminary Findings

Due to unforeseen circumstances, the project started late and is behind schedule. As such, final results are not ready for analysis and only preliminary findings from teachers' anecdotal records are reported in this paper. For the final results, it is felt that it would be best to wait for a full school year of project implementation to collect students' profile data and students' achievement scores for comparison with those obtained from the previous school year.

In general, preliminary findings show that most of the at-risk students' attitude towards learning and school has improved. They show more interest in their school work, especially the project work; and are more willing to work on the class assignments. Their self-confidence has also improved as evidenced by their readiness to communicate with their teachers and classmates, and to participate in class discussion and presentation. The teachers' enthusiasm remain high as they become increasingly adept at and comfortable with allowing their students to play a more contributive and active role in the teaching-learning process in the classroom. They also feel that the students' presentations in class and the additional materials sourced by them have made teaching-learning activities in the classroom more interesting and stimulating.

Conclusion

Although no conclusive data are available just yet to prove the project's worth in improving students' achievement, the preliminary findings obtained thus far from teachers' anecdotal records are encouraging. At the very least, this kind of cooperative learning activities have, to some extent, provided teachers the opportunity to work with and pay more individual attention to the at-risk students who are in dire need of it. At the same time, the cooperative learning activities allow these students to play a more leading and contributive role in the classroom, thus improving their motivation and self-confidence. Last but not least, the teachers are no longer tied to their traditional role of one-way delivery of instruction without any input or participation from their students.

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The Statistical Adviser: Recent Developments and Field Validation

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Abstract: Eighteen volunteer graduate students (nine males and nine females) primarily from the Department of Educational Psychology used a Windows-based statistical expert system (i.e., Statistical Adviser) to select the appropriate statistical technique for three research problems. Participants also completed a qualitative feedback survey, and an audit trail was used to analyze the decision-making strategy participants used in obtaining a solution. Participants' ability to effectively utilize the Statistical Adviser program to reach an acceptable solution appeared to be related to their ability to comprehend the research scenarios and translate aspects of the research scenario into concepts and terms that matched the program's queries. Female participants and participants with at least two previous statistics courses obtained more acceptable solutions. Also, participants who obtained a successful solution on the first research scenario were more likely to obtain further successful solutions.

Introduction

Though there have been significant advances in the field of statistics (e.g., structural equation modeling) over the past two decades, these developments have not always been incorporated into statistics and methods curriculum. Aiken, West, Sechrest, and Reno (1990) were alarmed by the findings of their survey of 186 of the 222 psychology departments in North America that the American Psychology Association identified as offering a Ph.D. degree. Only one-quarter of all recent graduates were judged competent at applying basic test theory concepts such as reliability, validity, and item analysis. One-third of all programs had no faculty trained to teach statistics and research methods, and topic coverage in most courses resembled that of 20 years ago. Increasingly, educators are exploring the use of computer-aided instruction (Varnhagen & Zumbo, 1990) and expert systems (Boncella, 1990; Saleem & Azad, 1992) in addressing these deficiencies.

Boncella (1990) suggests expert systems can play a vital role as consultants in the field of statistical education. An expert system can be defined as "the embodiment within a computer of a knowledge-based component, from an expert skill, in such a form that the system can offer intelligent advice or make an intelligent decision about a processing function" (Forsyth, 1984, p. 10). Expert systems attempt to tap into the domain knowledge and problem-solving strategies of experts, and make these accessible to novices.

Discussions of the issues regarding the development of expert systems in statistics were provided by Gale (1986) and Hand (1984, 1985, 1986, 1987, 1990). Hand (1985) has provided recommendations for expert systems in statistics. The statistical expert system needs to be adaptable to incorporate new knowledge and new techniques. It should explain why it is asking a particular question or recommending a particular technique. It should also explain technical terms so as to be user-friendly for the statistically naive. Ideally, the statistical expert system should recommend multiple techniques. Capabilities for both exploratory data analysis and formal hypothesis testing should be provided. The statistical expert system needs to adapt and make changes as the analysis occurs. For example, a different analysis may be required if the assumptions for a statistical technique are not met. The system must be flexible to enable users to backtrack when necessary and flexible enough to permit experienced users to override recommendations. Questions should be sensible and build on previous questions. An ordering of techniques is necessary. Users should be able to store their results. A teaching function would be helpful. Ideally, the program would be self-contained.

The Statistical Adviser (Sandals & Pyryt, 1992, 1993, 1994)is a Windows-based, graphical user interface, mouse-driven expert system that poses inquiries regarding aspects of the research problem, such as the number of variables, types of scales, purpose of analysis, fidelity to statistical assumptions, and then recommends appropriate techniques based on the decision-tree in *A Guide for Selecting Statistical Techniques for the Social Sciences* (Andrews, Klem, Davidson, O'Malley, & Rodgers, 1981). The program also includes a tutorial with a sample problem, a glossary of frequently-used statistical terms, and several appendices that provide reference lists, identify new or rarely-used techniques, and supply the syntax for executing statistical techniques in any of several computer statistical packages (i.e., SPSS, SAS, SYSTAT, MYSTAT, and MINITAB) on various computer platforms (i.e., WINDOWS, DOS, MACINTOSH, and UNIX). The purpose of this study was to conduct a field validation of the "Statistical Adviser". The intent of the study was to determine if the statistical decisions participants obtained using the Statistical Adviser expert system were congruent with decisions recommended by academic statisticians. The researchers were also interested in the decision-path participants used in coming to a statistical solution, and in any differences related to age, gender, degree program, and number of statistical courses taken.

Method

Participants

Eighteen volunteer graduate students participated in a field study in the spring of 1995. Gender representation was balanced with nine male and nine female students, and all students except one were from the Department of Educational Psychology. Twelve of the eighteen participants were completing a Master's degree and six were completing a Doctoral degree. Participants had taken an average of three statistics courses (mean = 3; S.D. = 1). Participants' ages ranged from 22 to 46 years, with a mean of 32 years and standard deviation of 6 years.

Measures

Eight research scenarios previously used by Sandals and Pyryt (1994) drawn from Pagano (1994) served as stimuli. The scenarios represented two chi-square problems, three correlation problems, and three analysis of variance problems. Each research scenario consisted of a brief paragraph describing a sample research problem and an accompanying table. Participants used the bottom of each scenario to record the statistical technique recommended by the Statistical Adviser program.

For the purpose of this field study, the Statistical Adviser program was modified to create a "dribble file" of each computer screen. This file served as an audit trail of each participants' decision-path as they developed a solution for the scenarios.

A Statistical Adviser Feedback Survey form solicited participants' feedback to four open-ended questions, namely: Please describe your impressions of the research problem. Please describe your impressions of the Statistical Adviser. In what ways could the Statistical Adviser be improved ? Can you identify specific situations where you would find the Statistical Adviser a useful tool ? Participants were also asked to identify their age, gender, current degree program, faculty, and total number of Statistics courses taken.

Procedures

Participants were recruited using descriptive information sheets posted across the university campus and verbal solicitations in several statistics classes. Students who expressed an interest were given an information letter and consent form. After granting verbal and written consent, participants were provided with three research scenarios representing a chi-square, correlation and analysis of variance problem. For each type of problem, the particular scenario was randomly selected and the chi-square, correlation and ANOVA problems were presented in random order. Participants were asked to use the Statistical Adviser program to determine an appropriate statistical technique for each scenario. An "audit trail" of the decision-path followed by each participant was automatically logged by the program in a "dribble file". When participants were satisfied with the recommendation presented by the Statistical Adviser, they recorded their answer on the research scenario sheet. Upon completion of the three scenarios, participants responded to the Feedback Survey form.

Results

Research Scenario Solutions

Participants' Statistical Adviser-assisted statistical decisions were compared with the decisions recommended by academic statisticians (i.e., chi-square, correlation, analysis of variance). An initial analysis of the data revealed that only four participants (22%) obtained the chi-square solution, one participant (6%) obtained the correlation solution, and one participant (6%) obtained the analysis of variance solution.

An inspection of the decision-path audit file revealed that several participants had distinguished between dependent and independent variables in the scenarios. This prompted the Statistical Adviser program to recommend the statistical techniques of Goodman and Kruskal's tau b, regression, and F-test for the chi-square, correlation and ANOVA scenarios, respectively. An examination of the research scenarios suggested such an interpretation might be justified. These alternative responses were therefore accepted, resulting in eight acceptable responses (44%) for the chi-square / Goodman and Kruskal's tau b scenario, eight acceptable responses (44%) for the correlation / regression scenario, and two acceptable responses (11%) for the ANOVA / F-test scenario. Six participants (33%) obtained two acceptable scenario solutions and one participant (6%) obtained three acceptable scenario solutions. In total, participants obtained acceptable solutions for 18 of the 54 (33%) scenarios.

The low number of acceptable responses for the ANOVA scenario suggests that participants had more difficulty comprehending this scenario. The ANOVA scenario required participants to navigate slightly more steps (8) in the Statistical Adviser program logic than the correlation (4), regression (7), chi-square (6) or tau b (7) solutions, and required participants to respond to more complex inquiries (e.g., assumption of homoscedasticity across levels of the independent variable). Participants effectiveness in reaching an acceptable solution may have been influenced by their comprehension of the research scenarios and the complexity of the decision-path required to obtain an acceptable solution.

The scenarios were presented in random order, and participants obtained acceptable solutions for seven of the first scenarios, five of the second scenarios, and six of the third scenarios. Of the seven participants who obtained an acceptable solution for the first scenario, three (43%) obtained an acceptable solution on the second scenario and four (57%) obtained an acceptable solution on the third scenario. Six of eight participants (75%) who obtained an acceptable chi-square / tau b solution also obtained an acceptable correlation / regression solution. Participants' effectiveness in reaching an acceptable solution may have been influenced by their ability to extract statistical concepts from the research scenario and translate those into responses to the program's queries. Those who were able to accomplish this with the first scenario (or with the chi-square or correlation scenario) were more likely to obtain acceptable responses with other scenarios.

Audit Trail

An examination of the audit file revealed that 32 of 36 wrong answers (89%) were related to two basic errors in participants' interpretation of the scenarios: number of variables, and type of scale (i.e., nominal, ordinal, or interval). In 18 of 36 instance (50%) where participants obtained an incorrect solution, they had misinterpreted the number of variables involved in the problem (see Figure 2). For example, in ten of these instances, participants interpreted the multiple groups in the ANOVA scenarios as multiple variables rather as multiple conditions of a single variable. Several participants also interpreted the two dichotomous conditions in the chi-square scenarios as four variables rather than as two two-point variables. In 14 of 36 instances (39%) where participants reached an incorrect solution, they had incorrectly identified the type of scale (i.e., nominal, ordinal, or interval). For example, six participants identified an interval measure in the correlation scenario as nominal or ordinal. In the ANOVA scenarios, several participants interpreted the ANOVA conditions (e.g., age groups) as an ordinal rather than nominal measure.

Demographic Variables

The number of acceptable responses were cross-tabulated with participants' age, gender, degree program, and number of Statistics courses taken. An examination of the table suggests that female participants and those who had taken more than two statistics courses obtained more acceptable solutions. Since both male and female participants had taken an average of three statistics courses (i.e., mean = 3, S.D. = 1), these factors appeared to be independent of each other. Participants' age and degree program appeared unrelated to their scenario solutions.

Qualitative Feedback

All participants described the research scenarios as simple, straightforward and understandable, using terms such as: "clearly written", "straightforward", "elementary", "basic" and "realistic". Twelve participants (67%) viewed the program positively, with one expressing reservations about the target audience (i.e., experts vs. novices). Participants with positive views believed the program was "well-laid out" and "easy-to-use", and appreciated the glossary, appendix and tutorial features. Five participants (28%) suggested the program would be useful in working through problems in a statistics course and four participants (22%) believed the program would be helpful in their thesis or dissertation work and in other research projects. Several participants also noted the program's potential for exploring various approaches to problem analysis and clarifying a research design. Four participants (22%) expressed strong negative opinions of the Statistical Adviser program (e.g., "confusing and intimidating") and three other participants (17%) expressed some concerns that the program "required a high level of background knowledge" and might be "designed for expert use".

Ten participants (56%) suggested the program could be improved by providing examples of key concepts and terms, such as examples of various types of scales. Five participants (28%) also recommended that simpler terms be used throughout the program. Other suggestions included the incorporation of a hypertext or "find" function in the glossary, addition of a global "help" function, an expanded introduction, and more graphical rather than textual display of information.

Discussion

Participants ability to effectively utilize the Statistical Adviser program to reach an acceptable solution appeared to be related to their ability to comprehend the research scenarios and translate aspects of the research scenario into concepts and terms that matched the program's queries. Female participants and participants with at least two previous statistics courses obtained more acceptable solutions. Also, participants who obtained a successful solution on the first research scenario were more likely to obtain further successful solutions. Two-thirds of the participants expressed positive views regarding the Statistical Adviser program, and one-quarter believed the program would be a useful tool in working through problems in a statistical course and/or conducting thesis, dissertation and other research. Several participants also appreciated the program's potential to explore various approaches to problem analysis. Jackson, Edwards and Berger (1993) note that the essence of an effective computer-based design is the program's ability to "facilitate and regulate the exploration of alternatives on the part of the learner" (p. 415). Expert systems that stimulate thinking and prompt learning may be more effective than those that only provide expert advice and recommendations.

All participants described the research scenarios as simple and straightforward. However, participants reached acceptable solutions for only one-third of the scenarios. In almost 90% of the instances when an unacceptable solution was obtained, participants incorrectly identified the number of variables or type of scales involved in the scenario. In their written comments, more than half the participants suggested that the program should review and provide examples of key concepts and terms such as types of scales. Despite the fact that participants had taken an average of three statistical courses, they appeared to struggle with some basic statistical concepts. Mazur (1992) argues that a weak link in many interactive computer tools is inadequate supportive text that: orients users to the program's capabilities functions, provides content clarification when required, and motivates and encourages exploration. Though the Statistical Adviser incorporates a tutorial, glossary and several appendices, participants expressed a desire for further support in understanding key concepts and terms through the incorporation of extended help functions and a glossary search feature.

Several participants also expressed concerns that the program required a level of background knowledge they felt was beyond them or that the program was designed for use by experts. These comments, and the relatively low number of acceptable solutions, may reflect the difficulty some participants had in translating the research scenarios into the concepts and terms that the program's queries required . Jonassen, Wilson, Wang and Grabinger (1993) argue that many expert systems utilize objectivist designs that insulate users from the reasoning of the underlying knowledge base and disengage them from the decision-making process. Users who are unable to replicate the system's model in their own thinking may experience the expert system as confusing and frustrating. Such comments highlight the fact that although the IF-THEN rules and reasoning of the expert system reflect the wealth of the expert's knowledge, they can also impose a prescriptive sequence of interactions that prove counter-productive with some users. Jonassen et al. (1993) challenge expert system developers to explore constructivistic designs that enable users to represent their own thinking or represent causal logic in a content domain. Schwier (1993) echoes this concern and suggests that computer-based multimedia tools move from a prescriptive approach to a democratic interactive environment where users play a greater role in the interactive process. Yaziçi, Muthuswamy and Vila (1994) also stress the importance of flexible interface designs that accommodate varying cognitive styles and skills, particularly in high complex tasks and interactive decision-making processes.

Sandals and Pyryt (1994) found that first time users of the program had difficulties in the initial field-test. Results from the present field-test suggest that the addition of a single tutorial demonstration does not enhance a novice user's ability to navigate the Statistical Adviser to make correct statistical decisions. These difficulties can be minimized through demonstration and guided practice in research methods and statistics courses, which is currently being done at the University of Calgary.

The use of the audit trail in the present study yields interesting information about a respondent's interaction with the computer. This feature will be retained in future versions of the program.

In addition to additional field tests of enhanced versions of the Statistical Adviser, future research with this tool should focus on its use in research methods courses. With the glossary, reference section, and computer package information, the Statistical Adviser can easily be used as a statistical reference work.

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3D Interfaces for Training :
"Knowledge Cities and Learners as Tourists"

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Abstract: The paper illustrates how three-dimensional interfaces afford building learning environments that support a guided exploratory approach to learning, and how such support can be derived from the metaphor of the city as seen by a tourist. We investigate possible representational mappings between the urban landscape and the attractions of the city. The three-dimensional city-based symbolic representation works synergetically with the overlaps that exist between the learning process and the exploration of an unknown place, starting from the organization of the trip. Learners develop their competencies gradually and according to their preferred approach, by traversing the city landscape and by engaging in simulations of the tasks. The approach is illustrated with 3D Studio City, whose urban landscape has been conceived to learn a three-dimensional modeling and visualization software.

1. Introduction

Simulation as instructional strategy if often advocated to support constructivistic approaches to learning and as being intrinsically motivating. It naturally fits instructional situations in which there is a causal model, either quantitative or qualitative, underlying the phenomenon or process to be understood or the task to be learnt.

Approaches to the design of instructional simulations vary from the use of simulation in a rather didactic fashion, with emphasis on its illustrative power [Reigeluth & Schwartz, 1990], to the use of simulation for more open-ended exploration [Duchastel, 1993], to the use of simulation for recreating situational scenarios in which the learners actively participate, as in the goal based scenario (GBS) framework [Schank et al., 1994].

Some strengths of simulations. i.e. affording the possibility of learning by doing and learning from mistakes by experiencing the consequences of performing an action, are especially relevant in domains characterized by highly technical and conceptually demanding tasks, as for example electronic circuit design or troubleshooting [Lajoie & Lesgold, 1989]. Structured practice in a simulated environment can be complemented by an exploratory or discovery component added to the learning environment, to jointly develop a sense of "what" is possible and of "how" it is possible. Examples would be learning a programming language or learning to use advanced features of software applications (e.g., a CAD environment, a word processor). In such situations learning procedural elements is intertwined with the need of developing a generative mental model of the tasks and of the domain that facilitates future learning.

A software tool is by itself a microworld, in which the consequence of actions can be immediately seen. However, initial barriers due to the complexity of procedures or to the fact that the underlying model of the system is not self-evident, most of the times discourage a learning by directly practicing in the environment. Classic solutions to this problem are the set of guided exercises that are commonly found in manuals. Yet such approach is poor with respect to contextual feedback on results and flexibility of exploration.

This paper shows how the metaphor of organizing and doing a trip to a city whose urban structure mirrors the structures of the task and contents can be a suitable framework to design learning environments for technical contents. The three dimensional landscape of the city affords layering the learning difficulties without compromising a unitary view of the nature and soul of the city. The approach is illustrated by means of a learning environment prototype that makes possible a trip to 3D Studio City, whose urban landscape is designed to learn a three-dimensional modeling and visualization software.

2. Metaphors or Simulation?

The approach that we propose is hybrid, because of the introduction of two main metaphorical components, the trip and the city landscape. The two metaphors operate in synergy to mediate the access to "spaces" in which an adequate degree of context and task fidelity [Alessi, 1988] is ensured. The reasons why there is no serious clash with the requirement of situational fidelity of "pure" simulations, are illustrated in the following.

2.1 The Trip Metaphor

The metaphor of the tour has been often used to introduce the organization of the contents, to provide a navigational structure, or to provide additional perspectives on the contents mediates by "guides". We extend this use based on the consideration that some aspects germane to the trip experience map easily to aspects fundamental to learning. In this sense we can consider the trip as an "experience" metaphor.

A trip to the same place can be organized in very different ways, based on constraints such as purpose, time and money available, interests and preferences of the traveler. This sort of dimensions are usually discussed in a travel agency, in the phase of trip organization. In the successful organization of the trip two factors concur: an accurate "self-analysis" on time, purposes, and autonomy degree, and an "agency" that is able to offer a customized solution. Travelers can be adventurous explorers who just want a ticket to their destination and organize everything else on their own, while others are at ease when everything is planned and organized in advance, and need local guides and support. This is practically isomorphic to how learners tend to approach a task based on their dispositions. In the same fashion, there is a varied typology of trips that maps nicely on the overall purposes for which a learning enterprise might be undertaken. Examples of trips are: a "relaxed" vacation, with plenty of time available to "dilute" experiences; a "standard" stay of one week, which implies a careful selection of what to visit and possibly some time available for unplanned explorations.

One can choose a destination because of some known attractions (e.g., the Tour Eiffel in Paris) which trigger the initial interest. However, most is learnt about the city when one is on site. In the most successful cases, the progressive acquisition of information leads to uncover interesting sides of the city that one would have not thought of. This is made possible by an effective deployment of information available at the right time with increasing detail. One can drop by at the tourist office, talk to the receptionist at the hotel, meet interesting people, or just follow the indications of a knowledgeable and responsive guide.

Another relevant aspect of the trip experience concerns the common practice (and wisdom) to monitor if the budget is respected, how much time is available for detours and unplanned excursions, how much of the attractions offered by the city has been enjoyed. In a learning situation these element may provide an anchor for relevant metacognitive processes. Also, the trip metaphor affords the opportunity of introducing some game component to make the environment more motivating [Malone, 1981]. Interestingly, the limits of application of the trip metaphor are not intrinsic, rather they are to be found in the natural or plausible correspondence that can be established between the trip destination and what has to be learnt.

2.2 The City Metaphor

Our cities are not conventional ones. Their architecture, their urban layout, their resources concur to create a conceptual landscape which maps the task and domain to be learnt. The approach is similar to the technique of scientific visualization, i.e., the visual representation of abstract data to detect patterns and meaning.

The effort required for building a three-dimensional representation to map the contents in the form of a urban landscape is justified especially when the domain is too abstract, broad and superficially homogeneous, and its basic structure and organization are not self-evident. The main challenge in finding effective three-dimensional representations to organize contents, domains, or practice scenarios aims to provide relevant flexible (varying in level of detail or perspective) but unitary views.

The urban landscape can be designed by first mapping specific topics to peculiar attractions of the city (typically buildings and sites) and then by mapping the other urban elements or facilities offered by the city into resources likely to be used in any learning situation. By associating a building to a specific topic, information on the type of content, on its context, and on the kind of activities to be performed, can be conveyed at a glance, based on: the *functional destination* of the building (e.g., is it a museum, a factory, a commercial center, a historical monument, a recreational center, and so on); the *style* or *shape* of the building (to be used if there is not an immediate mapping with the functional destination); the *volume* of the building, that might be related to the amount of information or to the degree of difficulty; the *location* of the building (e.g., downtown, the historical nucleus, the modern area, the residential area). The *height* of the building is a convenient way to

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denote increasing difficulty and more accomplished levels of expertise. In this case buildings are organized in floors and elevators are used to move from a level of difficulty to the other. Typically, downward exploration is always possible, whereas moving upward requires a pass, that can be related to entry requirements, or can be earned as more aspects are mastered.

The kind of topic also has an impact on the design and organization of the interior of the building. The organization of the interiors offers many opportunities for inducing mental models of the task or favoring certain patterns of exploration. For example, rooms can be laid out according to circular patterns for independent access to each room, or according to corridors that suggest a visiting path. Most of the "learning by doing" component takes place inside the buildings, where every room or space can be thought of as a scenario in which specific activities can be performed and their consequences are simulated.

Other elements amenable to creative utilization in the "knowledge cities" are: 1) the *hotel* (to rest, to reflect, to plan future excursions); 2) the *theater*, the *movie*, the *convention center* (where, for examples, some special events are scheduled, such as demonstration shows or round- tables with leading experts that are visiting the city); 3) the *gym* (for some special practice workout) and 4) the *pub* or the *café*, where opportunities for socialization and exchanging opinions are found.

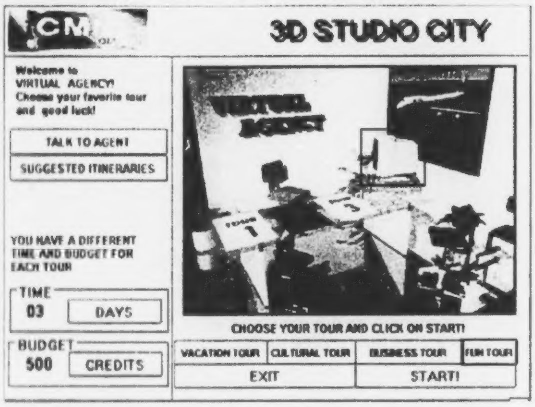
Navigation in the knowledge cities is made possible by the transportation system and by free movements inside the buildings. A surface transportation system (as opposed to an underground metro) can indirectly be used to provide an overall view of the city, even of those area that currently are not part of the exploration plan of the learner, and the stops can be designed to maximize efficiency in visiting certain sites. The city metaphor carries with it well known and tested navigational patterns that are part of everyone experience. The third dimension is a most important component to attain a sufficient degree of fidelity to effortlessly activate such behavioral patterns, and to reveal aspects normally lost or hidden in conventional organizations and representations of contents. Such considerations clarify the claim that one of the advantages of introducing the "city overlay" over simple collections of simulated scenarios for action and practice is that the city naturally provides a representation for the boundaries of the domain and that its resources are inherently organized for access and fruition.

3. A Case Study: "3D-Studio City"

We illustrate the synergy between the trip metaphor and the city metaphor with "3D-Studio City", a training environment for a software for modeling, visualization and animation: Autodesk 3D Studio. This prototype demonstrates some pedagogical issues and design solution adopted for building a viable interface to a three-dimensional world. The prototype architecture consists of three main components: 1) the city three-dimensional model (layout of the urban elements and of the transportation system); 2) the detailed model of each site, including the interior, the information and resources uniquely associated to the site; those directly accessible from the site; and the scenarios for practice and action; 3) the engine governing access to sites and the dynamic update of the visit opportunities. In the following how the prototype works is described.

3.1 Arranging the trip

The program starts by placing the learner in a *travel agency* [Fig.1], where different types of tour can be arranged. One can interact with the *agent* who introduces the resources of the City and possible ways to organize the stay. The purpose of the trip can be: for vacation, for culture, for business. Such typologies correspond to the level of expertise that the learner would like to attain (introductory, intermediate or advanced), and are used by the program to customize the suggested itineraries, the way certain type of information will be presented and how to test the learner. One can browse the tour description available on the table, and before committing to any decision can opt for the "Fun Tour", the shortest trip with emphasis on the more appealing attractions of the city. Agents also explain how time flows in the City and the role of the Credits. Time is measured in days that pass whenever the traveler will return to the hotel for the night (i.e., stopping the training session to resume it the next time). Credits are a way to make the learner aware of the effectiveness of their navigation choices. They are spent whenever a threshold of allowed number of visit to a site is exceeded, or when detours from the planned excursion do not lead to any accomplished result. Granted all the above options, the visitor can decide for the joys and pains of a self-organized trip, or resort to the services of personal *Cicerbots*. Finally, city maps, suggested itineraries, transportation tickets, passes for accessing the sites of interest at the right difficulty level are handed over to start the journey.



3D STUDIO CITY

Welcome to
VIRTUAL AGENCY!
Choose your favorite tour
and good luck!

YOU HAVE A DIFFERENT
TIME AND BUDGET FOR
EACH TOUR

TIME 03 DAYS

BUDGET 500 CREDITS

CHOOSE YOUR TOUR AND CLICK ON START!

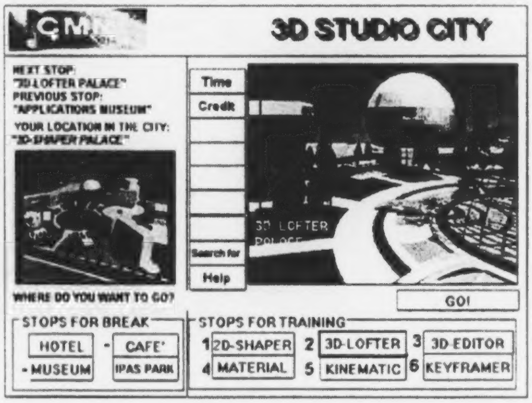
CM
TALK TO AGENT
SUGGESTED ITINERARIES
VACATION TOUR
CULTURAL TOUR
BUSINESS TOUR
FUN TOUR
EXIT
START!

Figure 1: Arranging the trip at the Travel Agency

3.2 Visiting 3D Studio City

After enjoying an air view of 3D Studio City from a plane, the traveler lands at the *airport*, where a *passport control* is required only if the traveler has not chosen a personalized tour at the agency. This allows for the program to collect personal information about the learner to manage training sessions spread in time. The first step is to take the *Shuttle* either to go to the Hotel or to reach a site selected from the map. For visitors who do not know anything about the city, at the Hotel there is a *Currency Office*, where, before starting their journey, visitors can get acquainted with the minimal definitions and concepts that allow a proficient visit of the city. Candidates for a first stop are the *"Applications Museum"* and the *"Techniques Museum"*. In the city metaphor it is fundamental to keep the typology of the building as close as possible to its real meaning. In a museum, for example, deeply diverse artifacts are collected together under a common denominator, often mirrored in the floors organization. Floors of the Application Museum correspond to: architectural applications, industrial design, multimedia programs, electronic art, all artifacts being produced with Autodesk 3D Studio. The Techniques Museum is organized in four floors, corresponding to Theory of color, Shooting techniques, Fundamentals of animation, and Graphic formats.

The core of 3D City are its 6 *"Modular Palaces"*: 2D-Shaper, 3D-Lofter, 3D-Editor, Material-Editor, Keyframer, and Kinematic. How to reach a Modular Palace by taking the Shuttle and is shown in [Fig. 2].



3D STUDIO CITY

NEXT STOP:
"3D-LOFTER PALACE"
PREVIOUS STOP:
"APPLICATIONS MUSEUM"
YOUR LOCATION IN THE CITY:
"3D-SHAPER PALACE"

WHERE DO YOU WANT TO GO?

CM
Time
Credit
Search for
Help
3D LOFTER PALACE
GO!
STOPS FOR BREAK
HOTEL
CAFE'
MUSEUM
IPAS PARK
STOPS FOR TRAINING
1 2D-SHAPER
2 3D-LOFTER
3 3D-EDITOR
4 MATERIAL
5 KINEMATIC
6 KEYFRAMER

Figure 2: Using the Shuttle to navigate 3D Studio City

Palaces are mono-thematic, their architecture and overall volume denotes the kind of topic and the overall quantity of information, while floors conform to the level of difficulty. The Modular Palaces are situated along a sequential path, for an implicit suggestion on how to visit them and maximize the time available.

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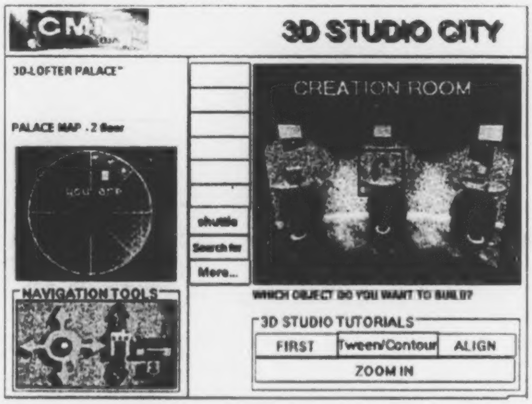
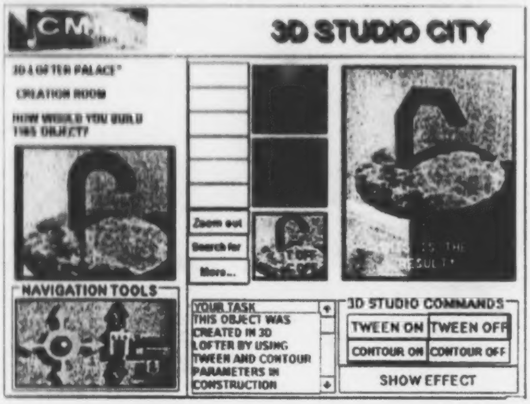
While in the Shuttle one has a situational view of the area that is being traversed (big window on the right) and information on the more general context (small window on the left). One can ask for stops for training, or for recreational stops. A 'search for" option is available to locate specific rooms or objects within a building.
Each building has three floors, which correspond to a low, medium and high difficulty level. In every floor are rooms with scenarios for activities. [Fig. 3] illustrates one of such situations.


3D STUDIO CITY
3D-LOFTER PALACE"
PALACE MAP . 2 floor
CREATION ROOM
shuttle
Search for
More...
NAVIGATION TOOLS
3D STUDIO TUTORIALS
FIRST
Tween/Contour
ALIGN
ZOOM IN

WHICH OBJECT DO YOU WANT TO BUILD?

Figure 3: Selecting a scenario for activity in the Creation Room of 3D-Lofter Palace

The learner is currently in the 3D-Lofter Palace, and each room in the floor (shown in the Palace map) has a number of objects that might be created by applying specific sequences of commands. The purpose of the simulation is to experiment the effect of the application of certain commands sequences. Once the practice scenario has been chosen the learner is presented with an interface [Fig. 4] in which a selected portion of the real 3D Studio software with the relevant commands is available to experiment. Actions lead to result that are immediately compared with the intended one, and a visual record of the effects achieved is available too.


3D STUDIO CITY
3D-LOFTER PALACE"
CREATION ROOM
Zoom out
Search for
More...
NAVIGATION TOOLS
3D STUDIO COMMANDS
TWEEN ON
TWEEN OFF
CONTOUR ON
CONTOUR OFF
SHOW EFFECT

HOW WOULD YOU BUILD THIS OBJECT?

YOUR TASK
THIS OBJECT WAS CREATED IN 3D LOFTER BY USING TWEEN AND CONTOUR PARAMETERS IN CONSTRUCTION

Figure 4: Simulating the effects of command sequences in one scenario of the Creation Room

The learner can take a break by dropping by at the *Internet Café*. This is the place where most of the social life of 3D City takes place. One can join the lively world of Internet based discussion groups around the topics of major interest, and participate actively, by posing questions and seeking answers. The City affords many more attractions. In the surroundings there is the amazing *Silicon Park*, where one can get acquainted with the possibilities afforded by the IPAS (Image, Procedural, Animated, Solid external processes) module "Silicon Garden" to create lawns, trees, gardens, golf courses, forests, and so on. The *3D Special Effects Amusement Park*, has the *Planetarium*, for IPAS effects such as stars, comets, planets, and, why not, even fireworks; the

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Aquarium, for IPAS related to waves, sea surfaces, vortexes, liquefaction effects; and the *Biodome* where all the secrets behind rain, snow, wind, fire, smoke, vapor can be revealed. For the more advanced learners, a visit to the *Production Studios*, will satisfy curiosity on video post production. Concerning practice, 3D Studio City supports a twofold approach: practice is always embedded in the simulations driven by the learner; and there is the *fitness center* to be visited for special workouts "out of context", where the learner is challenged to solve exercises to ensure that "memories" of the trip are vivid and clear. A training session can be concluded by returning to the hotel, with the warning that too many interruptions (stay overnight) could not be productive. Opportunities offered by the city are dynamically updated according to the learner progress. This is reflected in the hotel a bulletin board displaying the upcoming special events, so that if they meet current goals and interests, a variation to the trip for the day after can be wisely planned. The original purpose of the trip can be re-negotiated by contacting the tourist office, provided that the learner is aware of the resources that will be needed to do so (i.e., more time, more effort, and so on). In the meantime, as long as the tourist visits 3D Studio City and participates in its culture a very sought after certificate is slowly composed, like a puzzle: the honorary citizenship of 3D Studio City, for distinguished cultural or technical contributions.

4. Some Design Issues

The city metaphor is quite flexible and can be extended or adapted for other situations. We have shown how it might work in a technical domain. The mapping task is facilitated if the purpose of the learning environment is to deal with knowledge that is intrinsically associated with a city, e.g., geography, history, economics, culture and traditions, or aspects of science and technique. However, to be successful, the design of "Knowledge Cities" requires careful consideration of some issues. First, designing the landscape of the city is not a straightforward task. For the result to be plausible and enjoyable it is necessary the integration of notions of urban design and the mastery of 3D modeling tools in an approach to landscape design that is fundamentally guided by interactivity principles [Giordano & Giordano, 1995]. Effective layering of information seems to be more an art than a science. Issues to take into account concern whether partial disclosure of what is in the upper floors is needed to motivate the learner to earn the pass or whether curiosity alone is sufficient. Future formulation of design principles looking at the trade-offs of hiding and disclosing information with respect to the creation of a robust and accurate mental model in the learner would certainly be useful. Ensuring the live link to the discussion group on the technical matters, whenever these are available, seems to be a fundamental component of the knowledge cities. A main consequence is a simplified design of the agents populating the city, who are mainly confined to the role of providing introductory information and eventually pointing out more relevant resources in the Internet Café. An open issue is finding three-dimensional representations for contents and information both flexible in detail level and still unitary. We are currently experimenting with symbolic three-dimensional representations of recurrent types in learning situations, e.g., fundamental topics, simple but time consuming tasks, operations that are not time consuming but are conceptually sophisticated (expert tricks), notions of difficulty, relevance and interest. Also of concern is the feasibility of adapting some aspects of the landscape, the maps, and the navigational tools to the preference of the user, based on a personal semantic of shapes provided by the user by answering few questions on the meaning that certain shapes convey.

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On-line Collaborative Research: Web Constellations Meets a Book called *Points of Viewing Children's Thinking*

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Abstract

This paper integrates the theoretical intersection among ethnography, feminist theory, and epistemology within the larger context of an interactive learning environment for distributed electronic research communities. The particular environment examined is a Web-linked book, currently in press with Lawrence Erlbaum Associates, *Points of Viewing Children's Thinking: A Digital Ethnographer's Journey* which will be one of the first books affording readers an ability to annotate and view video segments described in the text. A generic tool, Web Constellations, for this interactive book/on-line-data link is described that enables researchers to add their views and interpretations and then to use this tool for their own knowledge building collaborative research data sets. Our intention is to provoke the research community into rethinking its traditional assumptions about solitary scholarship, explaining how digital media can be used to create more collaborative research environments.

Introduction: Expanding the WWW as a Platform for Shared Research

The World Wide Web offers a vast range of possibilities in the building and sharing of knowledge — possibilities that have yet to be fully understood by the research community across the social sciences. Although the web is full of activity, specific tools have yet to be devised that focus on a critical aspect of conducting research on the Web, the fact that data, text or video, can more readily be changed, moved, shared, and reconstituted. Within the purview of this paper, we hope to address several issues posed by the promise and crisis in this form of participatory knowledge construction. A new research tool, called Web Constellations, has been designed to encourage multiple users to work collaboratively on shared data sets. While the theoretical basis of Web Constellations has been to look at the more narrowly focused aspect of how traditional notions of cultural contexts might change in and through our roles as researchers using the Web, our technical goal has been to build this prototype in a way that enhances our abilities to tell our research "stories" on the Internet and to encourage others to share their stories.

Theoretical Framework: Creating Participatory Research Communities

A window of opportunity has finally opened upon levels of collaboration that once only "radical" feminists identified as the missing link in the history of knowledge construction (Grumet, 1988; Harraway, 1991; Turkle, 1995; & Britzman, 1993). Tools for collaboration using networked technologies offer researchers the opportunity to connect and negotiate interpretations leading to theories of knowledge that are more inclusive.

The Web offers the opportunity for this more inclusive cross-cultural paradigm concerning the generation of human knowledge — a paradigm that also runs parallel to the tenets also embedded within situated learning (Lave, 1988; etc.), ethnographic research methodology (Geertz, 1988; Lather, 1996), and constructionist knowledge-building (Papert, 1980& 1996; diSessa, 1985; Bereiter and Scardamalia, 1985).

The Web also offers the basis of building collaborative learning environments. One of the authors of this paper has also been using the Web to build a collaborative work-site, known as Studio A, that supports high school programs in Information Technology Management (Willinsky & Forssman, 1997). The students form project teams through the Web site to support the information technology requirements of their school and community, including training, curriculum support, repair, management, and planning. One area where this collaborative problem -solving service-driven approach has proven effective is in addressing the masculine space associated with technology, with more young women being drawn to using technology to provide services and find greater independence in the curriculum (Willinsky, 1996).

Our history shows, for example, that women have traditionally been excluded from the use and design of technologies. Research environments, whether in a physical location on a tract of land or in a networked environment, need to be places where ideas can grow and be nurtured with one's peers and "teachers" regardless of gender, class or race. They need to be places with private and public boundaries, where views can be challenged, and where ownership of ideas, especially when these ideas are socially constructed, is respected and acknowledged within the community of practice. Researchers using this electronic platform for intellectual discourse need to not only be voyagers or navigators using the tools for "gathering" data; they need to see this space as their social responsibility, a space to initiate discussion, to draw attention to its potentials and pitfalls, and to test the enactment of these technologies. This platform, or what one of us has termed a "platform for multi-loguing" (Goldman-Segall, 1995), ensures that researchers will be making informed decisions about the technologies on which scholarly work is increasingly dependent.

Data have recently become available to readers in seemingly less mediated forms through the use of Web-based technologies. Some would say that these raw and less filtered data are more accessible and thus more "truthful" than the highly constructed final versions of texts that appear in our current media — books, journal articles, films, and video reports. However, the film ethnography community has taught us that even the raw data (or footage) not yet molded into products are shaped by the author's choice, framing, or handling, and, that "the value of an ethnography or a film ... must be judged on the appropriateness of what has been included and how it has been handled" (Heider, 1976, 17). Framing and handling data are mediated actions that add filters. And although putting data on the Web for multiple readers to view is perhaps less mediated than the publication of only the analyses, researchers are still framing their data with constructs that reflect their own reference points, selecting which data are most representative for what they want to demonstrate (Minh-Ha, 1992). In short, framing is the optimal word here. How we frame our data consists of more than the categories within which we place them for the analyses. Analyses are taking place at every juncture as we place our views, our points of viewing, upon what we choose to select as "data" and how we juxtapose these data with other data.

Networked technologies can change basic search and retrieval methods by enabling the context of the story to accompany the less descriptive data markers or key words — the qualitative to accompany the quantitative — without forfeiting the robustness of the categorical. To start this form of multi-voiced interactive storytelling, one needs to start with annotation tools, simple spaces to comment upon what was seen, heard and read by readers and authors alike and build clusters of segments, scenes and scenarios, and finally stories that convey our interpretations of events.

Designing a Web-Linked Book for Shared Knowledge Construction

This project goes about exploring the possibilities of knowledge building on the Web in two ways, both historically, in a way that moves into the future, and practically in building an exemplar and templates. The historical approach places these new technologies in relation to previous print technologies for organizing learning (Willinsky, 1991; Willinsky, 1994); it also examines the political economy of the Web that affords a new means of educational empire by new media for the dominant cultures of the globe (Willinsky, in press). But in support of this historical analysis, we also seek to shape the future of the Web by demonstrating a deliberately collaborative knowledge building environment, featuring a bridge between historical and future technologies. We also wanted to present our data in ways which afford many points of viewing. And, to establish a way that researchers could learn from on-line data, while recognizing their tendency in this slippery medium to be manipulated (Goldman-Segall, 1995). Addressing these issues, we established an exemplar that yields alternative conceptual frameworks.

The Template

The first template we are developing is a Web-linked book, currently in press with Lawrence Erlbaum Associates, *Points of Viewing Children's Thinking: A Digital Ethnographer's Journey* by one of the authors of this article, Goldman-Segall. It is probably be one of the first books affording readers an ability to annotate and view video segments described in the text. Building upon her decade of experience in designing video data analysis research tools, such as *Constellations*, a template for this interactive book/on-line-data link has been designed for researchers to add their views and interpretations using a customized version of Web Constellations. The project builds upon and extends an existing software tool, Constellations designed by Goldman-Segall and Halff, bringing it into a Web-based environment. This prototype aims at stretching the Web's ability to facilitate collaborative, Web-based knowledge construction as well as a critical assessment of the potential impact these technologies can have on the social sciences.

Overview of Methodological Considerations

To encourage conversations with those participating in this new medium, whether they be other researchers or members of the global community at large, we became conscious of our responsibility to be as inclusive as possible in our role as researchers while we researched the research process in and through this new medium. After all, greater inclusivity and access is part of the promise of this new technology.

We started with a premise gleaned from our previous works that paradigms are changing and we now have tools for a more expressive form of inquiry. For example, ethnographies can use a variety of media forms to convey and create meaning in the minds of readers and viewers (Eisner, 1992). In fact, one of our researchers' previous research indicates that research on the Web is already a collaborative platform where those we study can become part of our research process and those who read the results of our studies can enter into a conversation with us and with those studied (Goldman-Segall, 1993, 1995 & in press).

The historical inquiry that we are undertaking attempts to move our thinking (1) backwards through a history of literacies that considers the knowledge building capacities of the text, illustration, table, book, library, encyclopedia, and database, to put developments on the Web into proper perspective, and (2) forward through speculative forms of computer science (Moravec, 1992), cyborg manifestations and manifestoes (Haraway, 1991),) and science fiction depictions of cyberpunk in the novels of William Gibson and others. This work has been designed to inform and form part of the content of the Web development that this project represents.

The obvious first step in this construction process was to think through what new technologies and global networks offer in ways of collaborating on the ethnographic research process by consulting with both researchers and research subjects, and by exploring theoretical and speculative envisionings of the technologies' potential. The works by and conversations with Glorianna Davenport at MIT (1996), Ron Baecker at University of Toronto (Harrison & Baecker, 1991), and Lucy Suchman at Xerox Parc (Suchman, 1987), David Jonesson at University of Pennsylvania (Dufffy & Jonesson, 1992), and Kellogg Booth at UBC have been instrumental in our design. In the second step, we have drawn up existing software tools that facilitate the building of on-line data analysis tools. Our third step has been to design an environment for the use of Web Constellations, using *Points of Viewing Children's Thinking: A Digital Ethnographer's Journey*. And in our coming research, we will address the quality of interaction, collaboration, community building, and finally the understanding of knowledge that arises in working with research data and analysis in these new ways.

Bringing A Book to Life: A Web Site and a Tool Called Web Constellations

The design of the book's web site integrates the principle themes of the book- storyreading, storymaking, and storytelling — with the research methods described and data presented. Readers can view source video as part of their reading of the book; make their own story by annotating video pieces and building meaningful constellations of video pieces; and tell their story by making their annotations and constellations avaliable to other readers, entering into a conversation with a distributed community. Web Constellations enables users to view a chunk of video, for example, and add annotations, and cluster the (star) chunks into constellations. In this way, the coded database of material becomes an expanding body of material for collaborative research.

A tool in its own right, Web Constellations enables researchers to create stars [Fig. 1] from any piece of information which can be described by a URL, such as a chunk of video on a web server, tag those stars with keywords, add annotations to their stars and other resarcher's stars. This coded database of material becomes an expanding body of material for collaborative research as users locate stars based using a simple search mechanism [Fig. 2], cluster stars found through searchers into constellations, and continue to annotate stars and the constellations built from them.

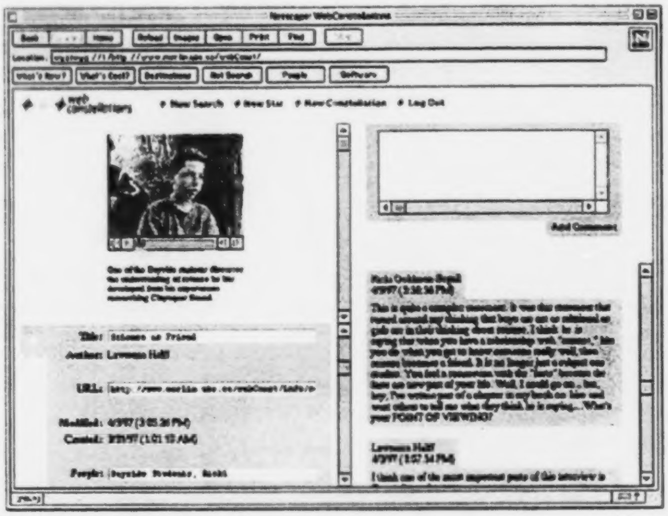

Figure 1: A Star in Web Constellations

Web Constellations system runs on a Web server, which allows researchers to access this system from any machine in any location provided thay have a reasonably fast connection to the Internet (depending on the kind of data being analysed) and a browser which supports JavaScript 1.1 or better. Researchers don't have to worry about saving their work to their own system or sending updated fiels to colleagues. While the actual database program runs in one server location, the data referred to by the stars can exist anywhere on the internet. This means that distributed research teams can make their data available for analysis as quickly as it can be made available as a file on their web server; and heavy data loads can be distributed amoung several locations.

As a system to enable collaborative storyreading, making, and telling, the customized version of Web Constalltions for the book will allow a more limited and directed set of features, which will focus on data interpretation and presentation. Throughout the book readers will encounter pages with video strips on them, showing frames captured from the source video discussed on that page or in that section. They can then enter the address of our website followed by a slash and the page number as a URL in their browser, and they will be shown the video clip within the custom Web Constellations environment. From within this environment, they can read other peoples annotations of that video clip and then add their own. They can still use the search function or an online index to locate other video clips and gather them into constellations, building their own narratives. These narratives themselves can then be further annotated by their authors and other readers who are

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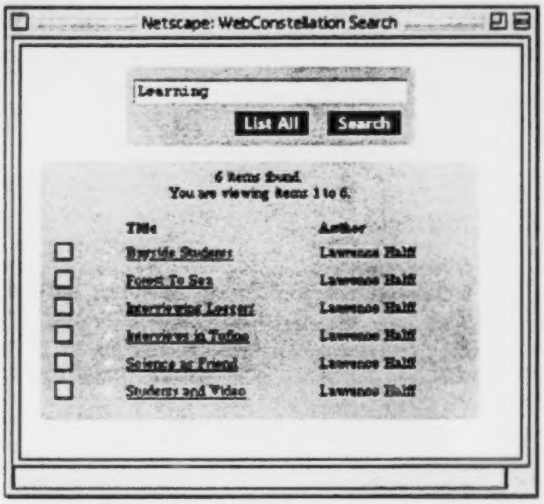
entering this environment and participating in the processes of reading, making, and telling. This digital environment not only blurs the authors and readers roles in a very concerete way, it facilitates the development of a global community of reader/authors.



Netscape: WebConstellation Search

Learning

6 items found.
You are viewing items 1 to 6.

	Title	Author
☐	Bayside Students	Lawrence Halff
☐	Forest To Sea	Lawrence Halff
☐	Interviewing Lessons	Lawrence Halff
☐	Interviews in Tofino	Lawrence Halff
☐	Science as Friend	Lawrence Halff
☐	Students and Video	Lawrence Halff

Figure 2: Results of A Web Constellations Search

Outcomes

Three outcomes from this book/Web site template using Web Constellations seem to be emerging as we forge on with our design process: (1) digital-data-capture with various media facilitates on-going collaborative access and analysis to those data; (2) the methods of working with data on the Web include "data-mining" and data-linking in ways that further "mechanize" the research process without loosing the storytelling nature of the endeavor; and, (3) the scope of knowledge-sharing include the possibility of greater community building within both the research community and the broader educational community.

(1) Digital Data Capture: The Web for Ethnographic Story-Making

In text-based ethnographic approaches, fieldnotes become constructed into text stories or case studies according to well-known traditions of storytelling and storyreading. But digital video "fieldnotes" living on the net can be manipulated into a range of configurations by multiple "authors" and then reconstituted into unrecognizable video bits and bites. They can be retold as portraits. (And, we forsee, they will be able to take on personae (Stone, 1996; Turkle, 1996) that were never ascribed by the author to these digital "creatures.") At each point, new layers of interpretation are added by selecting and cutting away from a whole or adding new materials to build an artifact. With the addition of intelligent agents to these creatures, they could begin to function for their authors' purposes (Sheeth and Maes, 1993; Davenport, 1996; Negroponte, 1996) as stories are built by multiple authors, if we decide to continue in this direction.

Using the Web for ethnographic investigation, there is the problem of adding complexity that will need to be entangled over the coming years. How will we, as a community of inquiry, be able to make meaning of these digital events? Moreover, each time the representation media form changes, e.g., text to video or video to networked video on the Web, another layer of interpretation and complexity is added. In the multimedia ethnographies Goldman-Segall has conducted in two school sites (Goldman-Segall, 1990 & 1997), layers of interpretations have been added by multiple users, including those persons who are being videotaped. As we watch others view these portraits, interpretations change further. The process of mining one's own data is endless, recursive and even exhausting in it conceptual and operational open-endedness. However, with tools that enable greater scene building, the organizational integrity can be maintained without loosing the flexibility.

Networked digital video portraits enable the viewer to virtually "be there" in situ and interact with the people being described as the research is being conducted. Is this the end of ethnography as we know it, and the

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beginning of a form of knowing others and "being with" others that includes the researcher and the viewer as actors in an evolving story?

(2) Digital Data Manipulation: The Web and Intelligent Agents

Utilizing the visions afforded by the information highway, we see extensive implications as educational researchers become increasingly wired, doing more of their knowledge-work in a networked space, and ultimately augmenting the data landscape of the human sciences. We situate the research community as members of a vast Web of interconnected researchers, constantly being fed by new data, continuously generating new connections, as they search, clip, and paste their way through research databases, adding further layers of experience-into-data and data-into-experience.

Digital data analysis tools have a serious consequence for the human sciences in the age of information technology — the question of what counts as knowledge in relation to what is emerging as an automated, global hyper-networked body of data, regulated and, perhaps generated through recombinant algorithms, by intelligent agents. What happens to distinctions of representation, authenticity, and validity, of data, information, and knowledge? What becomes of the researcher as data-mediator and data-constructor? These questions seem to be paramount to any building of an inclusive research framework. Questions that, we believe, should be asked by our community before they are answered by the manufacturers of technologies. It is the responsibility of researchers, whose search for constructing knowledge bases are critical to the well-being of many disciplinary and increasingly multi-disciplinary fields of inquiry, to explore these questions as a community.

In short, in building our framework for research, we have attempted, in this paper, to set one template in place that demonstrates the process of transforming "data" or "information" into knowledges and theories, thereby facilitating the construction of a greater variety of knowledge frames. We see this as a deliberate attempt to understand and take greater control of the new research environments afforded by the Web. We seek to establish a forum for exploring alternative paradigms to the specter of increasing automation of the research process. We are developing experimental sites for experimenting with new levels of engagement in the data and analysis process represented by *Points of Viewing Children's Thinking*. We want to explore the epistemological prospects of knowledge-building as a historical process that encompasses earlier technologies of the book, type, library, encyclopedia, and database (Mumford, 1934; Neill, 1995). At issue are the ways in which we assemble knowledge as a definition of how we engage the world. Rather than succumbing to the forms of technological determinism found in the work of those who, like Neil Postman (1992) and Ursula Franklin (1990), would warn of us of the dangers ahead to our humanity, we feel the important task is to build prototypes and models of different ways *being with technology*, of using it to realize what we want and do not want of the world. On building those prototypes and models, which is work currently underway, the next step will be to engage the academic community in exploring through an interactive Website, the look and feel, the potential value and danger, and the range of options sparked by this approach to collaborative research settings.

(3) The Scope of Knowledge-Sharing.

One of the principal outcomes of this work will be to propose a way of responding to new technologies that will full take advantage of Web resources to create innovative forums of engagement and response. The line between sharing and building knowledge will be blurred. Beginning with the original prototypes and models that are now being mounted on the Web, participants will be invited to actively shape the knowledge environment, propose alternative settings and structures, and collaborate on research and reflection in how these new forms operate in extending the nature of the book, the mediation of data, and the automation of research processes. The intent is not to capture the results of the collaboration, but to trace the collaborative process as it creates an intersection for knowledge sharing and constructing. The sharing, then, represents a reflective cycle that learns from the positive and negative possibilities of these new environments, while users are actively engaged in building new models and perspectives. What begins with the traditional format of the book in this project, namely Goldman-Segall's *Points of Viewing Children's Thinking*, becomes its own historical journey across the media, disciplinary and genre boundaries in what could be posed as a collaborative epistemological adventure.

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Real-Life Education and Training in Virtual Networks

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Abstract: In engineering education it is important to provide the students a possibility to become involved in "real life" development projects. The infrastructure for the production, delivery and presentation of network-based learning has matured to a stage, where it has become viable to involve distributed teams of students in the development of electronic course materials. To provide a conceptual basis for such development activities, we have devised a framework for the production, delivery and presentation of network-based courses. In addition to the framework we describe a few projects illustrating our early experiments in how the work of distributed teams acting as "virtual companies" can be organized in the development of educational and training products.

1 Introduction

The novelty of the medium and the technological capabilities can not justify development of network-based courses anymore. To be successful in the future, we need to take a product view of network-based education, where the criteria for evaluating learning products (e.g. electronic courses) include educational validity, cost factors, and the ability to meet the specific needs of customers. The educational evaluation includes such factors as learning outcomes and instructional models; the cost factors include production, delivery and presentation costs per unit delivered. In many cases it is also increasingly important to be able to deliver specifically tailored education at the "point-of-need". We need to provide customized on-demand learning based on systems that support cost-efficient distributed production and delivery of education.

Traditionally education and training have been institutionalized and tied to physical locations. The network-based models provide flexibility in time and space but are often still replicating the conventional educational structures. However, the new medium makes it possible to further dilute the boundaries between the different modes of education and the different providers and customers of learning. New forms of co-operation and collaborative alliances can be formed between educational institutions, training companies, in-house training departments and product vendors. Together they operate as "virtual companies", where each partner contributes their own special expertise to the production of the course.

In this paper we first present a conceptual framework for network-based courses, that we have been using for guiding the design and development process. Thereafter we propose a product view of education for the creation of "electronic markets for learning" to encourage re-use of educational materials but also to provide appropriate incentives and rewards to the providers involved. Finally, we describe some actual projects, in which we have applied the framework and also started to develop the notion of "virtual companies" in collaborative projects between educational institutions and industry, in the development of education and training products.

2 A Framework for Network-Based Education

The explosive supply of educational resources on the Internet combined with the availability of powerful tools for information publishing, multimedia, and for collaboration across distances are useful building blocks for network-based courses. However, to make good use of them, there is a need for comprehensive design and delivery frameworks for cost-efficient and effective electronic course production, delivery and presentation. These frameworks should help in integrating the different modes of learning and provide guidance for the implementation of network-based course production and learning systems. Also, they should support the revision of educational paradigms [Agogino & Wood 94],[Hämäläinen 96]) enabled and furthered by appropriate use of information technology.

One of the key objectives of the two recent international projects that EVITech is involved in, Project CODE and ARIADNE, is to address the cost-efficiency of education provision. Project CODE was initiated in June 1994 as an international coalition among three institutions sharing a vision of student-centered flexible learning as enabled by the convergence of information technology: Espoo-Vantaa Institute of Technology (EVITech) in Finland (co-ordinator), Microelectronics Educational Development Centre (MEDC) in Scotland and the Center for Information Systems Management at the University of Texas at Austin (UT/CISM) in the USA (project overview is available at: *http://www.code.evitech.fi*). ARIADNE - Alliance of Remote Instructional Authoring & Distribution Networks for Europe - is a research and technology development (RTD) project in the "Telematics for Education and Training" sector of the 4th Framework Program for R&D of the European Union. Description of the project and full list of partners is available at: *http://ariadne.unil.ch*. ARIADNE project focuses on tools and methodologies for producing, managing and reusing computer-based pedagogical elements and telematics supported training curricula. Validation of the project's concepts is due to take place in various academic and corporate sites across Europe. In CODE the objectives are similar but more explicitly focusing on supporting specific learning approaches (resource-based and collaborative learning) and on customer-driven production and delivery of education and training (see [Hämäläinen 96] and [Hämäläinen et al. 96]).

One of the most striking features of the current educational systems is the enormous duplicated effort that goes into the production and presentation of the same courses in thousands of locations with marginal reuse or sharing of efforts. To address these problems the learners' and course providers' work is organized around "pedagogical knowledge pools" [Forte et al. 96] or "course material repositories" (in CODE) combined with appropriate submission, retrieval, sharing, reuse and course composition mechanisms. In the following we describe the CODE model and tools in more detail.

2.1 Learner's View

The learning approaches that are explicitly supported by the CODE model are resource-based learning and collaborative learning. These approaches are consistent with the needs of customized on-demand education and have been demonstrated to work well also in network-based distance learning courses ([Alexander 94] and [Dorairaju et al. 94]). The course delivery consists of the following elements which are accessible via the learning environment that provides the learner an interface to various work and resource spaces as illustrated in Figure 1:

- *electronic books:* course materials (textbooks and learning tools) available either locally or remotely and customized to the needs of homogeneous groups of learners
- *virtual library:* relevant external/internal information resources often linked to course materials
- *study tools:* applications designed to assist in the learning process
- *collaboration tools:* applications and procedures for collaborative work enabling asynchronous and synchronous communication between students and instructors as well as among students
- *assessment and feedback tools* for self-evaluation as well as for instructor assessment and feedback

The learning environment aims at supporting both on-line and off-line learning by integrating asynchronous and synchronous multimedia communication with electronic learning resources on the local workstation and on the Internet [Watabe et al. 95]. The learning resources are available in the *resource space* and consist both of course materials (i.e., "electronic books") and of external information resources available on the network (i.e. "virtual library"). The course materials have been composed and customized for the course being presented while the vast information resources and services accessible via the network are provided "as is" as reference materials. Some of the relevant external resources may be linked to the course materials while others can be found by search mechanisms used by the learners. For improving access and reducing communication costs it is in many cases essential to make the bulk of the course materials also available at learner's local workstation. This may happen either by delivering a CD-ROM or providing mechanisms for batch delivery from the network server to the local workstation still retaining the material's original structure and functionality as much as possible.

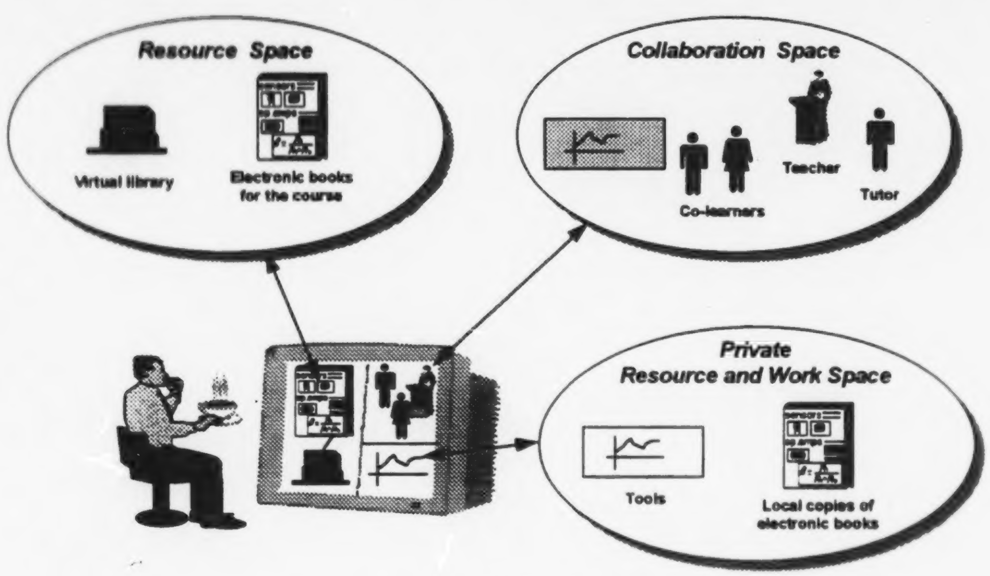
Resource Space
Virtual library
Electronic books for the course
Collaboration Space
Teacher
Co-learners
Tutor
Private Resource and Work Space
Tools
Local copies of electronic books

Figure 1: Learner's View of a Course in the CODE Environment

Course production and customization is based on course material repositories, where learning material elements are represented as structured documents using standard document encoding languages (SGML, and HTML in particular). Support for distribution of the production and presentation of courses and methods to facilitate reuse and customization of the material are among the main objectives. A number of prototype implementations of tools and systems have been developed on top of the WWW, to enable testing of the feasibility of the model proposed. Among them are:

- *QuizTool*, an exam and feedback system based on SGML-encoded exam and answer files. It includes tools to support exam authoring in the MSWord environment, and alternative exam presentation and analysis systems. These are implemented on the Web-server as CGI-programs for on-line use, and as Java-applications for both on-line and off-line use (e.g. for CD-ROM based material)
- *DiscourseWeb*, a structured discourse and annotation system allowing hierarchical annotation chains on WWW pages (to help in integrating resource-based and collaborative learning)
- *WebCourser*, a prototype for electronic course broker combining a course material repository and a customization system based on customer/learner profiles and course element descriptors.

2.2 Towards Education Brokerages

Actually, as one of the largest "information industries" in the world, education has the potential to be a key application in electronic commerce. As we move further into network-based delivery and presentation of courses it will become necessary to start developing electronic intermediaries or electronic course brokers that help in composing and delivering courses appropriate for the customers. These education brokers will operate on the "electronic markets for learning" to provide value-adding services both for the customers and suppliers of education [Hämäläinen et al. 96].

The conceptual framework that we have described above maps naturally to the Internet resources and Internet tools. By adding services on top of the current tools, in particular by extending the functionality of the WWW servers (via CGI) and clients (via Java-applets) it has become possible to implement a course broker as a set of software processes [Hämäläinen et al. 96]. In the broker model the delivery is based on customer order and the necessary transactions thereafter are coordinated by the broker. The electronic course broker is actually an example of electronic commerce applications [Kalakota & Whinston 96]. An Internet-based implementation of the course broker model (WebCourser) is currently being developed at EVITech. The task of the course broker is to compose a course, or set of alternatives, that match the needs and profile information of the customer. The implementation model based on practical document management and information retrieval techniques is illustrated in Figure 2. The retrieval of potential candidates for course elements is done automatically by matching the customer need and profile data with the course element header data. The actual course composition will require the user to make the final choices as well as the final structuring and fine tuning of the course.

3 Real-Life Cases

3.1 Computing English Updated - An Online Course for Language Learning

We started collaboration with Edita Oy in 1995. Edita is a leading company applying electronic publishing methods in Finland. They have developed SGML and HTML-based publishing for several years. The first product was the publishing of the multimedia book *Computing English Updated* on the WWW. The text and images of the book were converted from PageMaker format to HTML. The book has a lot of hypertext links to glossary items. After completing each unit the student can take the exercise session. The functionality of the exercise is planned according to the CODE model. There are free text answers, multiple selections and matching questions. The contents of the accompanying audio cassette was digitized and linked to the document. With a multimedia workstation the student can listen to narration and then answer the questions. All the answers are sent by email to the teacher. The student can also get the correct answers at his will. A demo of the product can be found in *http://www.edita.fi/edi/pankki/compeng_nayte/unit6.html.*

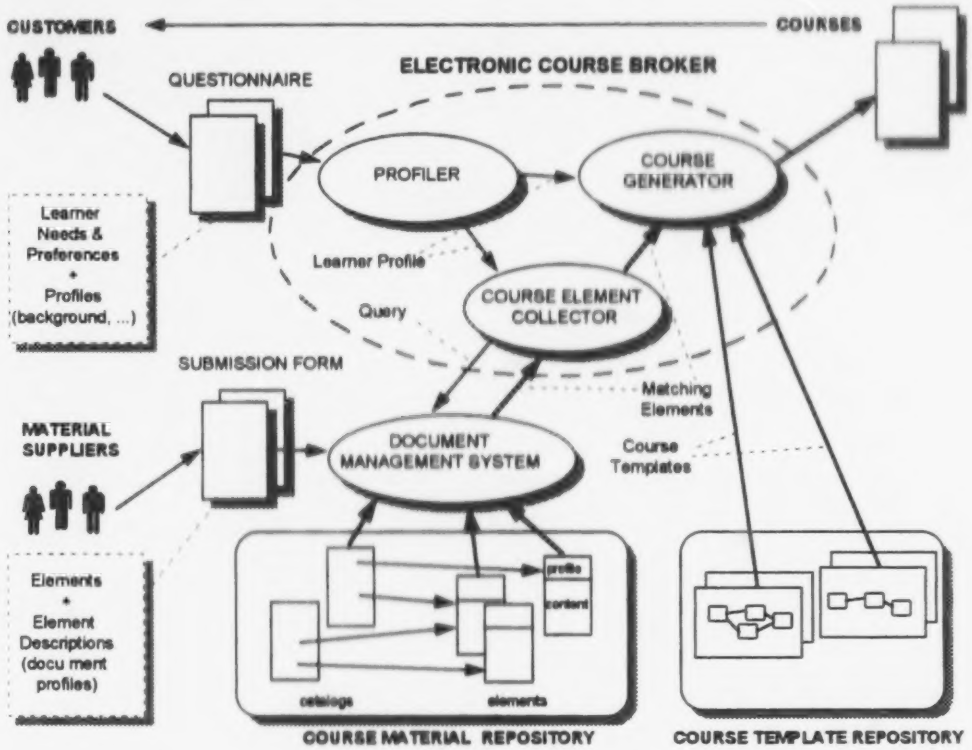
CUSTOMERS
COURSES
ELECTRONIC COURSE BROKER
QUESTIONNAIRE
PROFILER
COURSE GENERATOR
Learner Needs & Preferences + Profiles (background, ...)
Learner Profile
Query
COURSE ELEMENT COLLECTOR
SUBMISSION FORM
Matching Elements
MATERIAL SUPPLIERS
DOCUMENT MANAGEMENT SYSTEM
Course Templates
Elements + Element Descriptions (docu ment profiles)
profile
content
catalogs
elements
COURSE MATERIAL REPOSITORY
COURSE TEMPLATE REPOSITORY

Figure 2: **A Network-Based Course Broker**

3.2 Learning Infobahn (LIB)

A new international three years co-operation project *Learning Infobahn* (LIB) has been started at the beginning of 1996 together with three Finnish polytechnics (Espoo-Vantaa, Satakunta and Lahti), several universities and polytechnics in the USA and Germany, and SME companies in Finland. The project belongs to the re-industrialization program of the Finnish National Board of Education. The aim of the project is to:

- integrate art and technology in its functions
- start common pilot projects applying communications technology
- support the commercialization of communication products in SME sector
- develop the curricula of media polytechnics according to industrial needs
- acquire tools and contents for Learning Infobahn
- stimulate collaboration between USA, Germany and Finland by applying new communication technology
- support entrepreneurship of the students of media technology

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During the first year of the project two new SME multimedia projects have been launched: Development of a CD-ROM/WWW publication of the tourist services of Southern Finland (Human Capital Investment Inc) and electronic publishing of the National Biography of Finland (General Media Carnac). In both projects a virtual enterprise of about ten students was organized in a couple of weeks for developing demanding commercial multimedia applications. The next step we need to do, is to establish appropriate models and methods for project execution in such distributed teams.

4 Conclusions

New models of course production, delivery and presentation are needed to guide the education providers in implementing cost-efficient and also effective learning systems. With network-based delivery and presentation of courses, we can start envisioning education as one area of electronic commerce, where educational products can be composed from a number of suppliers, each focusing on their special expertise, thus forming a "virtual company" for the production and delivery process. The building blocks would include the repositories and broker services described above, combined with systems to handle copyrights, licensing, authentication, security, and electronic payments. Despite of all the administrative and technical obstacles, this may be closer to reality than we are willing to admit in the academic world.

We have found it useful to develop and further enhance the framework described at the beginning, to provide a conceptual basis for the "real life" collaboration projects in the area of network-based learning. These projects also are examples of our early steps in experimenting how the work of distributed teams in the "virtual companies" could be organized in the development of educational and training products. Only by trying out the ideas in industrial use the feasibility of the approach can be verified. For the primary mission of EVITech, the provision of high quality engineering education, we see these projects essential as they provide the students a possibility to become involved in real development projects, often already at an early stage of their studies. Much of the work described above has only been possible due to the commitment and efforts of the students involved in implementation of these systems.

Distributed team-work is already a well established and successful method in projects. However, we are now approaching the stage where starting a new project can involve the creation of a "virtual enterprise" for the design and execution of the project. The production, delivery and presentation models have matured to the level, where we can start adapting them to a variety of educational settings. The next possible course of action is to organize the produced content as elements of educational products, combine them with elements supplied by other material providers, and establish an education brokerage that has potential to sustain and develop its operations via appropriate licensing and payments schemes.

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Researching media and learning: a qualitative approach to data collection

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ABSTRACT: In qualitative research a wide variety of data formats is available to the researcher, including questionnaires, interview transcripts, videotapes, computer output, concept maps, artifacts, etc. This rich, unstructured data is not easy to handle and presents particular problems with indexing and analyzing; the potential outcomes, however, are complex and fascinating with inbuilt possibiltiies for triangulation. The paper describes one approach to the collection of unstructured data.

THE ISSUE

This paper describes a qualitative approach to the study of cognitive construction when using computers in a problem-based university course.

The students were in the professional years of an Architecture degree undertaking a unit called Building Systems in which they were required to work collaboratively on the development of 3D computer models. The course represented a significant change in teaching strategy and the accrediting body (Hon Kong Institute of Architects) required reassurance that this approach was as valid as the previous lecture-tutorial-project method. The HKIA suggested that the Department set up a comparative study in which an experimental group undertook the problem-based course and a control group followed the old course. This approach was not possible as there were insufficient resources to mount both courses. In any case, bearing in mind Clark's (Clark, 1983; Clark, 1994) meta-analyses of media comparison research, such a study would probably have demonstrated "no significant difference". (This is actually what the HKIA would have liked to hear!)

The teaching staff were convinced that the problem-based method would lead to more effective, though different types of learning and were interested in observing how students would use the sophisticated computer tools to construct knowledge. Therefore, rather than set up a laboratory-style, experimental study and devise a hypothesis, or a "no significant difference" null hypothesis, the researchers set themselves an open-ended question:

> *In a problem-based, computer intensive learning environment, what is the nature of the interaction between student characteristic, computers and cognition?*

It was decided to use a qualitative, data-driven approach: to observe the progress of the unit, to record what happened, to allow the issues to emerge from the data, then to attempt to construct some theoretical insights about the "nature of the interactions." The data were to be organized using the qualitative research tool NUD*IST (Non-numeric Unstructured Data - Indexing, Searching & Theory-building)

In this paper I will describe the range of unstructured data which was collected for this study and indicate briefly how it was used in the analysis and theory-building stage of the evaluative research.

THE STUDY

The main part of the study took place over a four month semester . Follow-up interviews were conducted in the following semester with eleven of the original students who continued with Building Systems II, and finally one year later, at the end of the degree program, all the students were interviewed again and given a follow-up PFNet.

The research question dictates that three types of data needed to be collected:

A) data relating to student characteristics (SPQ and entry level computer knowledge test)
B) data relating to the interaction between students and computers (mental models of the system and PFNets)
C) data related to cognitive construction (videotapes, interviews and artifacts)

(A) STUDENT CHARACTERISTICS

The profile data was collected in the first week of term. Two indicators were used: approach to study as measured by the Study Process Questionnaire and a test of entry-level knowledge in 3D computer modelling.

(I) APPROACH TO STUDY

The Study Process Questionnaire is the Hong Kong tertiary version of a questionnaire developed by Biggs (1991). It provides a profile of each student according to his/her predispositions to learning on three scales: Surface motive & strategy, Deep motive & strategy and Achieving motive & strategy. Students were tested in the first week of the term.

Figure 1 illustrates two students SPQ profiles, graphed as deviations from Biggs' Hong Kong university student norms (the 'normal' range is 3-7): Figure 1a shows a student who is within the normal range on both surface and deep approaches but appears to lack ambition; whereas the student in Figure 1b has well developed strategies for success.

Figure 1: SPQ scores as deviations from Biggs' H.4. norm

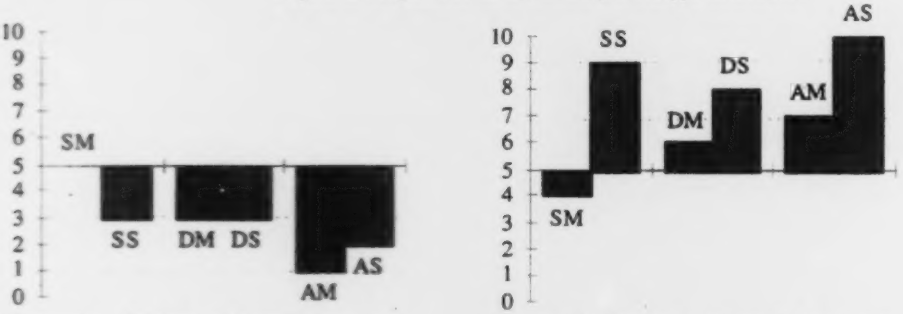

Figure 1a: Student with average to low scores on all scales

Figure 1b: Student with well-developed strategies

(II) COMPUTING KNOWLEDGE: MIND MAPS

Students were tested at the beginning of the unit on their computing knowledge. They were asked to create a 3D model in AutoCAD and describe what they were doing as they worked. The sessions were video- and audio-taped and then mind-mapped using Buzan's (1993) technique.

Figure 2: Mind maps of computing knowledge

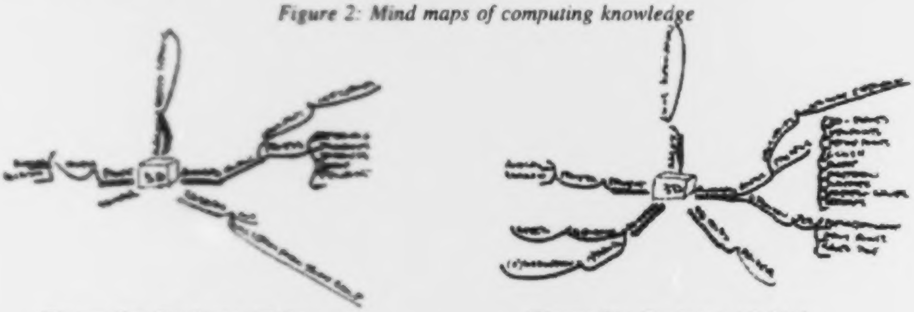

Figure 2a: Student with low declarative and contextual knowledge

Figure 2b: Student with high declarative knowledge of AutoCAD and contextual knowledge of computing.

Mind mapping involves identifying key concepts, looking for links between them, and developing these links into a branching structure from a central concept. Figure 2 illustrates two mind maps derived from the demonstrations of 3D computer modelling: the 3 o'clock branch divides into categories of knowledge about AutoCAD; 5 o'clock represents knowledge of other computer programs, such as 3D Studio, Photostyler and AME; 7 o'clock lists benefits of computer modelling in architecture; 9 o'clock categorizes ways in which computing will be used in the coming project; and the 12 o'clock branch is for metacognitive issues and insights on learning.

(B) INTERACTIONS BETWEEN STUDENTS AND COMPUTER

(I) MENTAL MODELS OF THE SERVER

Some weeks into the study the research team noticed that students were having great difficulty saving and finding their files. The researchers asked the students to draw a representation of their mental model of the computer system. The four representative images in Figure 3 clearly illustrate why some students were having difficulty.

Figure 3: Mental models of file structure

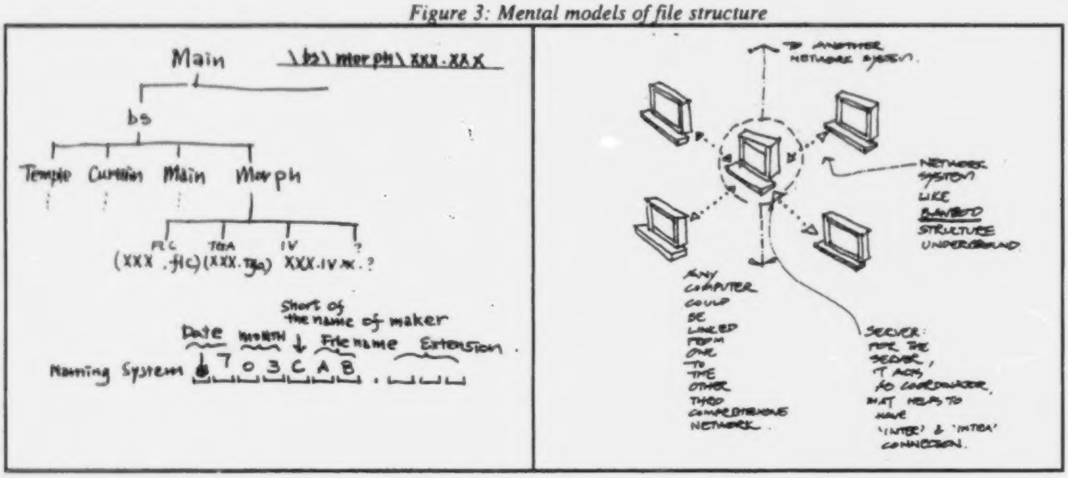
Main
\bs\morph\XXX.XXX
bs
Temple
Curtin
Main
Morph
FLC
TGA
IV
?
(XXX.flc)(XXX.Tga) XXX.IVxx.?
Short of the name of maker
Date
Month
File name
Extension
Naming System 6 7 0 3 C A B . _ _ _
TO ANOTHER NETWORK SYSTEM.
NETWORK SYSTEM LIKE BAMBOO STRUCTURE UNDERGROUND
ANY COMPUTER COULD BE LINKED FROM ONE TO THE OTHER THRO COMPREHENSIVE NETWORK.
SERVER: FOR THE SERVER, IT ACTS AS COORDINATOR, THAT HELPS TO HAVE 'INTER' & 'INTRA' CONNECTION.

Figure 3a: Hierarchical and accurate

Figure 3b: representational

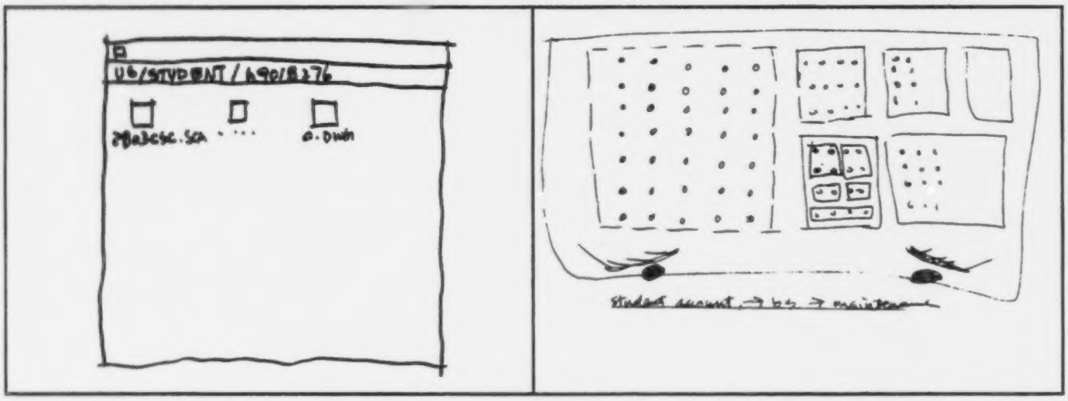
U6/STUDENT/b901827b
28abcsc.sca
a.Dwh
Student account → bs → maintree

Figure 3c: "Screen capture"

Figure 3d: Whimsical

Figure 3a is a reasonably accurate hierarchical model of the file structure produced by one of the group leaders, indicating that she had a clear picture of how files were organized on the server; Figure 3b is an architectural style of drawing showing five workstations and the links between them, the hidden computer network is described as being "like bamboo structure underground"; Figure 3c is a picture of the X-windows screen when the student first turns on the computer; and Figure 3d is a whimsical attempt to anthropomorphize the computer into a representation of a human brain, complete with eyes (the files are shown in the left frontal lobe!).

(II) STRUCTURAL KNOWLEDGE: PFNETS FOR CONCEPT MAPPING

Pathfinder networks (PFNets) result from semantic association tests in which subjects are asked to rank the "relatedness" of pairs of concepts. The resulting output is a graphic representation of the subject's concept map of a group of terms. It is a technique more commonly used in market research than learning research, but it proved to be a valuable tool, particularly when followed up by an interview in which the student was asked to interpret the resulting "network". (For further information on PFNets, see Schvaneveldt (1990)) The software used to produced the PFNets was KNOT.

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Figure 4: PFNet produced by KNOT

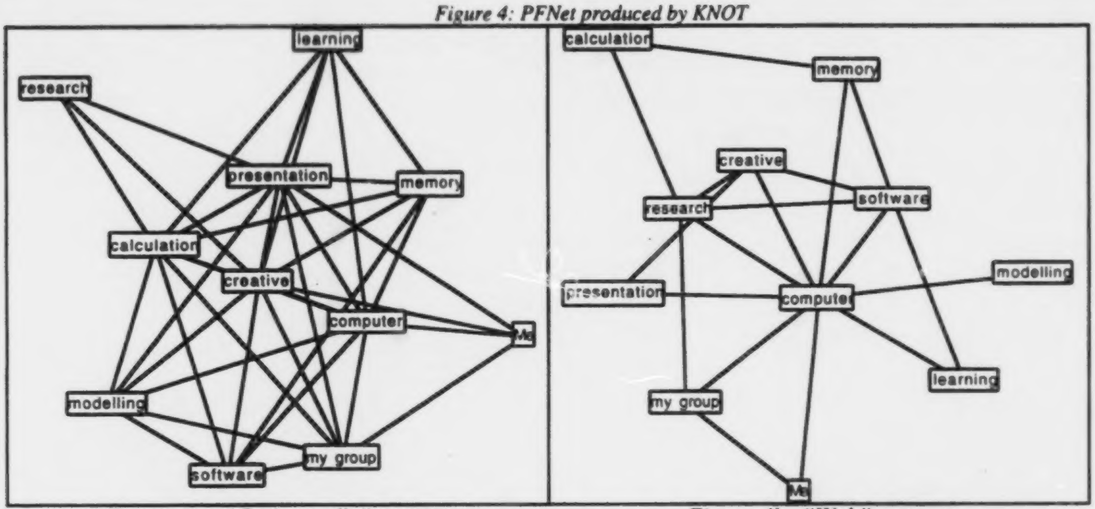

learning
research
presentation
memory
calculation
creative
computer
Me
modelling
my group
software
calculation
memory
creative
research
software
presentation
modelling
computer
learning
my group
Me

Figure 4a: "Cat's cradle" pattern

Figure 4b: "Web" pattern

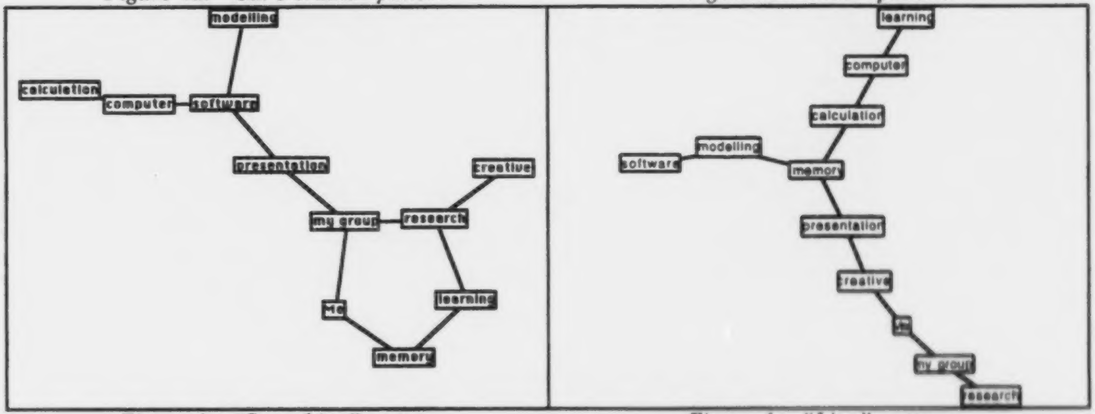

modelling
calculation
computer
software
presentation
creative
my group
research
Me
learning
memory
learning
computer
calculation
software
modelling
memory
presentation
creative
Me
my group
research

Figure 4c: "Branching" pattern

Figure 4c: "Line" pattern

Students were asked to do a semantic comparison test using 11 words which had been distilled from earlier interviews and had all become low-level nodes in the NUD*IST data base (*me, my group, computer, software, presentation, calculation, modelling, creative, research, learning, memory*). The aim of the exercise was to see how closely students related computers to themselves and their group as well as to concepts such as creativity and learning. Figure 4 illustrates four characteristic patterns from this exercise which appear to indicate the level of structural integration of domain (architectural) and computing knowledge.

The four patterns illustrated in Figure 4 show a progression of relatedness of concepts. In 4a all concepts are related equally, indicating either an excessively deep approach or the student's inability to make up her mind; in 4b everything is related to one central concept, in this case *computing*; 4c shows a well-structured branching pattern in which "personal" concepts (*me, learning, creativity*, etc.) are linked to computing concepts through the *project*; 4d is from a student who displayed a predominantly surface approach to learning - the single linking concept here is *memory* - note that *research* is at the maximum distance from *learning*.

(C) LEARNING

The teaching staff in Architecture saw learning as a constructivist process, the final outcome of which was to be the interactive 3D model. The evaluation of the learning experience, therefore, could not be accomplished using tests of declarative or even procedural knowledge. The team collected data on student progress continuously over the course of the term, using mixture of observation, interviews and artifact collection.

(I) VIDEO OBSERVATION

Class meetings and project demonstrations were covered on videotape using a Sony Video 8 Handicam with 12x zoom lens and built-in and extension microphones. Two types of set-up were used: hand-held (which proved technically difficult and was mainly employed for reference only) and off-screen recording incorporating picture-in-picture.

The most satisfactory result was obtained by recording directly from the SGI video port through a video converter onto the Handicam and combining this signal with the image from a fixed camera using a "picture-in-picture" device. The connection diagram is illustrated in Figure 5.

Figure 5: The video observation system

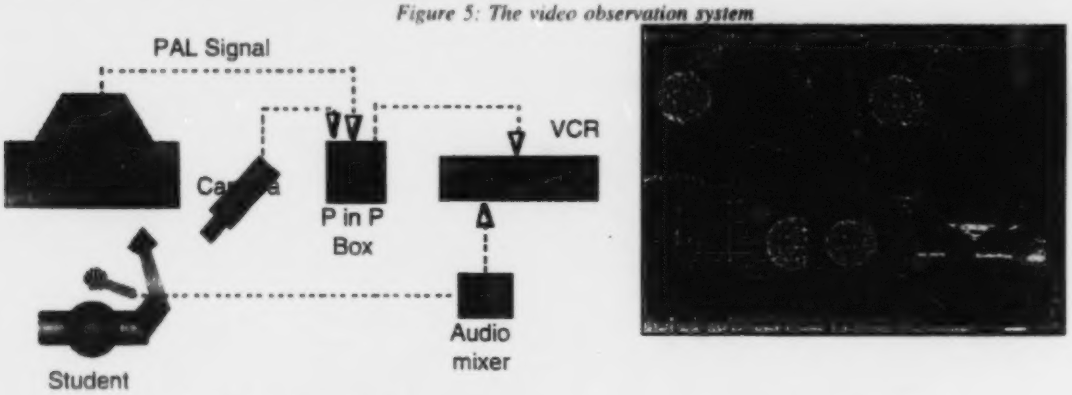


Figure 5a: Connection diagram

Figure 5b: Output

The *p-in-p* system was adjusted so that the computer screen comprised the main image and an image of the student was superimposed in one of the four corners. Figure 5b shows the student's image positioned at the lower right of the frame as this is normally the least used area of the screen in graphic work.

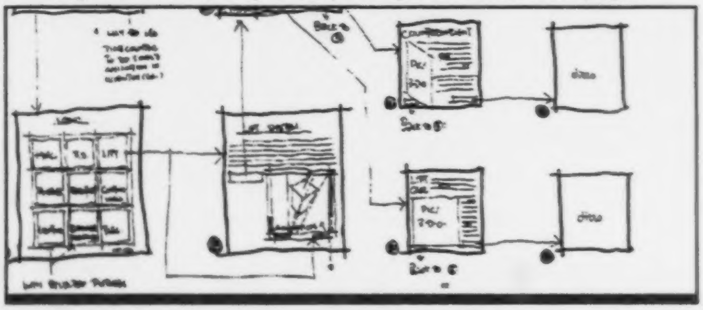
(II) TRANSCRIPTIONS

The videotapes were logged using a computer program called "C-Video", which enables the replay of the Sony Handicam to be controlled directly from the Macintosh numerical keypad by means of a cable between the computer's serial port and the LANC remote control plug on the Handicam. C-Video produces a text file which can be introduced directly into the NUD*IST data base, and enables time stamping of the transcript. The later interviews as well as interviews with teaching staff were recorded using audio only. The interviews were conducted in an office off the laboratory or in a staff office and were fairly informal and open-ended although a list of questions had always been prepared and were always asked — though not necessarily in the same order.

(III) ARTIFACTS

In addition to videotapes of students at work and transcriptions of interviews and demonstrations, the researchers collected media such as students' preliminary sketches, storyboards, etc. as well as scans, photographs, videotapes, screen captures, audiotapes, mind maps, etc. As much as possible of this material was converted into electronic form and stored on disk for easy reference. E.g. Figure 5b is one of a set of screen captures, or "key frames" made to accompany transcripts of videotaped sessions. Figure 6 is a detail from a computer scan of a preliminary storyboard.

Figure 6: Detail from first storyboard for the Maintenance project



The most important artifacts, of course, are the completed multimedia projects, impossible to illustrate in a printed paper. They are, however, available for inspection at the HKU Department of Architecture's World Wide Web site: http://arch/hku/hk (Student Projects/ Building Systems directories)

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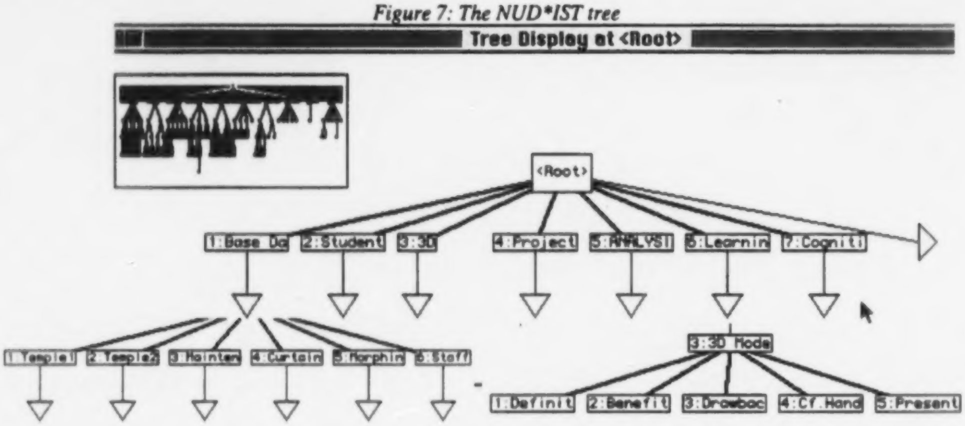
ANALYSIS

QSR NUD*IST is computer software for qualitative researchers which facilitates the handling of textual (on-line) and graphical, video and statistical (off-line) data. It provides an environment in which the researcher can create, manage and explore ideas and categories derived from the data. An example of one of the NUD*IST interfaces (the tree display) is illustrated in Figure 7

*Figure 7: The NUD*IST tree*



NUD*IST was the primary cognitive tool used to organize the data. Documents are imported into the program where they can be explored, creating categories at which text units are coded. They can then be searched for patterns in coding, from which new codes can be developed. Using the various interfaces, the researcher can clarify ideas, discover themes, construct and test theories, create memos about the data and finally generate reports including text extracts, coding patterns and statistical summaries.

There is insufficient space in this paper to go into the process of analysis and theory building which was followed in this project. Detailed discussion of the qualitative research issues is available in (Hart, 1996) and (Hart, Will, & Bradford, 1997).

In summary, the project demonstrated that:

- the problem-based, computer-intensive curriculum promoted a "deep" approach to learning,
- students valued the situated nature of the task,
- for the more successful students, the computer system was a cognitive tool, which they manipulated consciously, and
- the outcomes (the projects) demonstrated the development of complex cognitive constructions

The project was also able to point to aspects of teaching which needed to be more strongly reinforced, such as:

- the encouragement of metacognitive knowledge,
- the acceptance and utilization of distributed cognition, and
- the need to teach and reinforce contextual (in contrast to declarative and procedural) knowledge.

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Adaptive Testing and Multimedia for Vocational Guidance

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Introduction

Despite the importance of career decisions, people often feel a lack of competence in career decision making and do not know how to collect and evaluate appropriate informations. Recent tendencies of the job market force young adults to accquire optimal qualification in order to get adequate jobs. Therefore, improvements in pedagogical and psychological counselling methods are required. Professional and semi-professional software is at hand which promise to support career counseling processes. In what follows, we are describing the development and evaluation of a multimedia CD-ROM and an adaptive testing facility dedicated to provide vocational guidance. In this paper, we want to show how multimedia and individual adaptation can be used to support career decision making by providing vocational guidance.

Learning with multimedia

As of today, empirical research has not been able to support the enthusiastic visions of multimedia. In their most recent meta-analysis, Chen-Lin and James Kulik (1991) examined 248 research studies about computer-supported learning. 150 studies failed to show any significant effects. The other studies showed only a slight advantage of multimedia over textbooks or lectures: Error rates of simple retention tests were reduced between 5% to 15% ($Eta^2=.15$), problem solving was hardly enhanced, and study time was reduced between 20% to 70%, with an average reduction of time about 30% ($Eta^2=.35$). Considering all studies included into the meta-analysis, multimedia produced only a small effect ($Eta^2<.01$; Hasebrook, 1995a).

Although, multimedia seems to save some time and reduce simple learning errors, it has not been found be very effective as a problem solving tool. Clark and Craig (1992) investigated several meta-analysis, including the analysis by Kulik and Kulik (1991; Kulik, Bangert-Downs & Williams, 1983; Kulik, Kulik & Cohen, 1980). Their findings also indicate that multimedia applications are not overly effective. Most of the positive effects derive from general organizational and instructional changes in the learning environment.

Fortunately, however, there are also some promising studies showing that multimedia could potentially facilitate the learning processes. The Software Publishers Association (1995) reviewed the effect of instructional technologies in 133 school studies from 1990 to 1994. They found that there were better test results, an increase in self-reliance, and a closer interaction between students and teachers. Similarly, Boettcher (1993) collected "101 success stories in higher education" in his book. Thus, multimedia can help people to enhance communication, motivation, and self-efficacy. This, however, does not necessarily lead to better learning rates but it could potentially facilitate career decision making.

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The case of adadaptation

Duchastel (1992, pg. 69) claims: "Adaptation is essence of what is known as pedagogical knowledge". Many researchers aim to make their multimedia systems more adaptive – and therefore more "pedagogical" (e.g. Cox & Brna, 1995). Expert systems and Intelligent Tutoring Systems (ITS) adapt to the learner´s demands, abilities, and knowledge – especially in subjects which can be described in formal logics (Bastien, 1992). There is an increasing number of adaptive computer programs which is equipped with media like videos and photographs. Although there are no clear cut borders between expert systems, ITS, and other adaptive multimedia systems, Clancey (1987) divides expert system from ITS by two distinct features: (1) The knowlegde base of an ITS tries to model human knowledge, an expert system does not. (2) Expert systems are not equipped to support learning processes, because they do not explain their rule or knowledge bases and the inferences drawn from that bases. As of today, a diverse spectrum of techniques, approaches, and philosophies impeds the progress in intelligent learning environments (Self, 1992). There are promising results, however, supporting positive effects of intelligent learning environments teaching mathematics and programming (e.g. Weber, 1995). In general, effects of adaptation and system-controlled tutoring have been small or medium sized, yet (e.g. Rosenberg, 1990; Kelley, 1988).

Although knowledge based systems are well established tools, there are hardly any implementations of sytems for vocational diagnosing and counseling (Ueckert, 1995). Psychological testing procedures including computer-supported diagnosis are used to conduct aptitude tests in personnel selection (e.g. Sweetland & Keyer, 1984; Funke, 1993), to implement adaptive testing optimizing economy and performance of personality, aptitude, and ability tests (e.g. Cronbach & Gleser, 1965; Bennett, 1993), and to perform decision analysis applied to management diagnostics (Nagel, 1993). But there are hardly any computer-based, psychological testing procedures adressing vocational guidance. This does not mean, however, that there are no software products available: Counseling software guides list 200 programs, approximately, that are designed to support self assessment, job finding, and job keeping (Walz, Bleuer & Maze, 1989; Katz, 1993). About 100 titles incorporate surveys or self-testing facilities in order to provide the user with information about his or her career alternatives and prospects of career satisfaction.

Software to improve vocational guidance

Career decision making can be described as a system consisting of highly interactive components (Katz, 1993; Kerka, 1987):

- *Options:* They define what the decision is about, e.g. apply for a job or another, enroll in one educational program or another, accept or reject a job offer.
- *Persons:* This refers to the self-concept of the decision maker but also to the interaction with other relevant persons.
- *Environments:* Of course the social and the cultural contexts are important. Furthermore, job characteristics like actions, work load, independence, income, and security play an important role for the decision maker.
- *Processes:* This term refers to the ability and the actual course of decisions making.
- *Outcomes:* The outcomes of a decision process in terms of success, satisfaction, and efficiency may serve as an input for a new career decision making process.

All this components or dimensions are considered to be parts of a decision process that aims to minimize the difference between qualification, preferences, and requirements. Variations in the importance attached to each dimension by different individuals means that they can come up with different optimal outcomes (Holland, 1985; Katz, 1993). For example, some may especially want job security, high income, work in a main field of interest, and various combinations of such rewards. Career counseling software can support the counseling process in serveral aspects (Bridges, 1989; Kerka, 1987):

- The software can offer both instruction and practice (e.g. interviewing for jobs).
- Some programs have quizzes or exercises allowing an evaluation of career maturity or job hunting skills.
- The program can access information from large databases of job fields or careers.
- A large group of software allows users to answer questions about likes and dislikes and match them to careers.
- Some of this programs takes the repetitive work and tedious jobs away from the counselor, hence, enabling him or her to focus on interactive career counselling.

The most common complaints regarding these programs are (Katz, 1993; Bridges, 1989) poor usability, long response and searching times, a lack of adaptability to the audience, too few or inadequate assessment questions, and a lack of complete and up-to-date information. Based upon this considerations we developed an adaptive testing facility to support career decision making by matching interests and preferences with job characteristics. Additionally, a vocational encyclopaedia was produced to inform the user about relevant job characteristics like actions, work load, income, and so on (Hasebrook & Graßl, 1995). Our testing facility is not designed to mimic the full range of an interpersonal counseling process. Rather, it shall provide the user with a variety of job opportunities which match his or her personal interests and preferences. Figure 1 gives an overview of the system´s components.

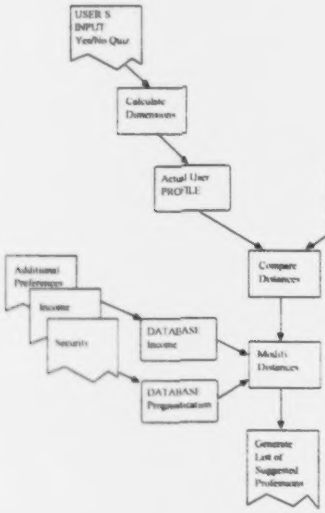
USER S INPUT Yes/No Quiz
EXPERTS RATINGS Job Survey
Calculate Dimensions
Calculate Dimensions
Actual User PROFILE
DATABASE Experts Ratings
Compare Distances
Additional Preferences
Income
Security
DATABASE Income
DATABASE Prognostications
Modify Distances
Generate List of Suggested Professions

Figure 1: Components of the testing facility supporting career decision making by matching individual interests and job characteristics.

Medialog produces a series of eight CD-ROM for microcomputers equipped with Windows 3.1 or Windows 95. Each CD-ROM applies to a certain occupational field like "Economics and Law", "Natural Sciences", and so on, and contains a vocational encyclopedia combined with the testing facility. In the beginning of a session the user enters his or her personal qualifications and conditions in order to allow the program to come up with reasonable suggestions and informations. The user decides whether he or she wants to examine occupational fields, to explore the index of the encyclopedia, or to take a job quiz. The quiz provides the user with up to 100 simple yes/no assessments. After having responded to 20 items the system signals to the user that it is ready to suggest jobs and educational programs. If the user accesses the list of suggested items he or she may jump into the encyclopedia by a simple mouse click and retrieve information about qualifications, tasks, work load, income, prognoses, and so on. All occupational fields and many jobs are illustrated by videos and photos in order to

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elaborate th text and give an realistic impression of work life (Hasebrook & Graßl, 1995). Figure 4 displays a block diagram and a screen shot of the graphical user interface of the CD-ROM.

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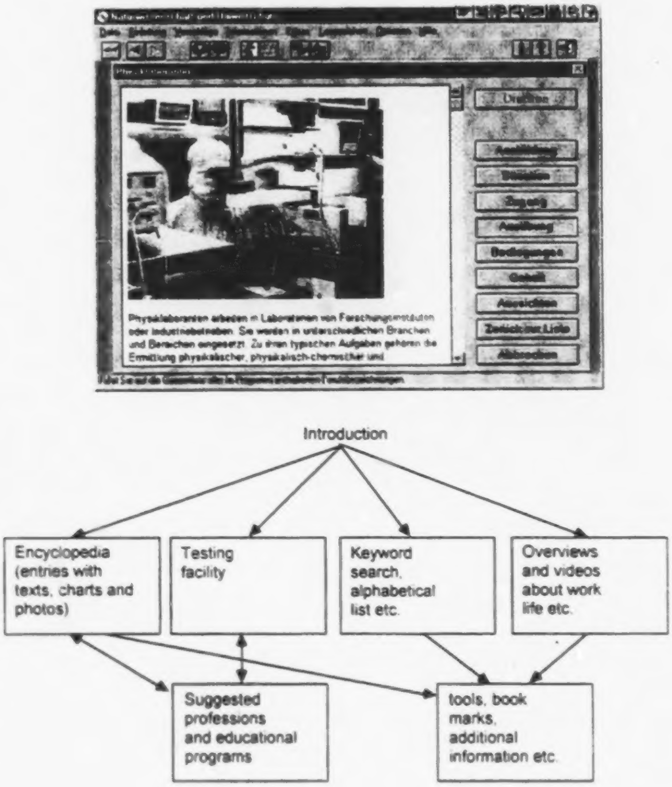

Physiklaboranten arbeiten in Laboratorien von Forschungsinstituten oder Industriebetrieben. Sie werden in unterschiedlichen Branchen und Bereichen eingesetzt. Zu ihren typischen Aufgaben gehören die Ermittlung physikalischer, physikalisch-chemischer und

Zugang
Gehalt
Aussichten
Zurück zur Liste
Abbrechen
Introduction
Encyclopedia (entries with texts, charts and photos)
Testing facility
Keyword search, alphabetical list etc.
Overviews and videos about work life etc.
Suggested professions and educational programs
tools, book marks, additional information etc.

Figure 2. Block diagram and screen shot of the CD-ROM "Career Counselor" with Yes/No quiz, list of suggested professions, and information from a vocational encyclopedia (screen displays an entry of the encyclopedia).

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Evaluating adaptation

There are several psychological inventories dedicated to measure career development and vocational maturity. One goal was to make valid prognostications of the career development and the vocational success. Most of the studies, however, show essential validity for short-term predicitions, only. Therefore, most investigations focus on enhancing construct validity. High construct validity, however, gives little support to career decision making and vocational guidance (Seifert, 1994). Therefore, we evaluated our adaptive testing facility for its practical validity – that is, how are the system's responses accepted by students and counseling experts. 43 students participated in an experiment to investigate the understanding and acceptance of the information provided by the system. Furthermore, we explore whether the system is able to reconstruct 38 expert's ratings.

We asked the students to rank four different job lists according to their judgement, whether the lists match their vocational interests or not. The students were told that the four lists were generated by four different computer programs. In fact, only one list was calculated by our computer system, three list consisted of random selections. The results show that students are able to judge, whether careers match their individual interests or not (cf. figure 3): They preferred individually calculated job lists compared to random lists ($F[3,122]=11,8$; $p<.001$; $Eta^2=.23$). But they were not able to tell them apart from a list which consists of well-kown jobs which do *not* match their interests (Scheffé $p>.05$). Therefore, the students' jugdements rely on weak criteria (sometimes) leading them to wrong conclusions. This assumption is confirmed by the data displayed in table 1: There are positive correlations between the students' judgements about...

- how well the suggested jobs match their interests,
- how well they know the suggested jobs (based upon concrete informations),
- and how well they can imagine what are typical professionals are doing.

However, there are negative correlations between all these variables and the actucal state of information: The more information the students have got, the less they are willing to accept suggestions – and the less they have got a feeling of knowing. Therefore, information leads to more scepticism and critics which is needed to carefully guide the career decicion making process.

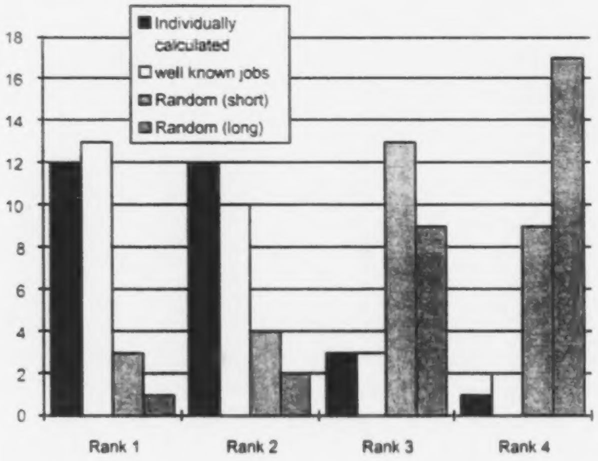

Figure 3: Students prefer individually calculated job lists – but they cannot tell them apart from well known, generally preferred jobs, which do *not* match their interests (n=29).

The system shows a good performance in reconstructing the experts' data – except of one academical career which was not described very clearly: The system correctly identified between 85% and 100% of the experts' ratings (academical career 42%). Adjusted goodness of fit scores (AGF) of a LISREL model were between .81 and .92 (Jöreskog & Sörbom, 1989).

Table 1: Correlations between questions concerning acceptance of the suggested jobs & information about jobs (n=43).

Content of question:	Match	Know	Imagine
Match			
Know	0,56		
Imagine	0,42	0,58	
Information	-0,49	-0,36	-0,34

Connecting multimedia and adaptation

In a recent study, we tested the influence of the adaptive testing facility and a software video on recall of information and individual acceptance by means of a 2x2 factorial design. The testing facility enabled the participants to enter their vocational interests and to receive a list of suggested jobs and educational programs from a multimedia encyclopedia. Additionally, all participants received the same list of jobs. The subjects were randomly assigned to the two video conditions: One group watched the video before reading further informations, the other group watched the video after having read the informations. The study has two parts: During the learning phase the participants read informations about jobs and educational programs; during the testing phase, all participants completed two surveys: (1) They rated the overall acceptance of the program, its functions, and its informations. (2) They completed a cued-recall task. Table 2 displays summarized scores from these surveys. The results confirm that video enhances acceptances ratings but does not influence recall (F[1,73]=.4; n.s.). Recall is clearly enhanced, however, when studying individualized materials compared to general informations (F[1,73]=13.9; $p<.01$; Eta^2=.16).

Table 2: Acceptance ratings (0=complete rejection, 25=complete acceptance) and cued recall (0=no recall; 25=complete recall) as a function of list of jobs (previously fixed list vs individually generated list) and video (displayed before vs after reading).

	Job			
	Previously fi:		Individually gen	
Watching Video	Before	After	Before	After
Accecptance	10,3	9,5	9,5	8,6
Cued Recall	8,2	6,8	11,5	11,2

Conclusion

Multimedia have potentials to enhance and facilitate career decision making. Most of the recent multimedia systems, however, show small positive effects or none at all. The effective use of multimedia is influenced by many internal and external factors, like motivation, knowledge, mode and contents of media, learning strategies, features of the task, etc. Making multimedia applications effective means to start from the user's perspective: Mostly, this implies to conduct a study about needs and abilities of the users (Hasebrook, 1995b).

Individually generated information clearly supported both acceptance and recall of vocational information. The effects were enhanced, if individual differences in usabilty ratings were taken into consideration. Our findings match other research results indicating that individually adapted informations enhance motivational and learning processes within computer-supported learning environments (Bastien, 1992; Weber, 1995; Cox & Brna, 1995).

Adaptability of the system clearly increases acceptance and performance of the system. But this does not neccessarily mean that one has to bother to make a system "intelligent": It certainly demands any effort to support the in-born intelligence of the user. Multimedia applications should not be designed to provide "something for everyone", but they should provide exactly the type of information that is needed in a particular state of the decision making process.

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Telecom and Open Learning - a Challenge to Institutional Co-operation

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Abstract: The increasing demand for professional updating and trends towards lifelong learning challenges the flexibility of higher educational institutions. Application of information technology and telecommunication seems to be one way of meeting these requirements. Open and distance learning (ODL) has to be provided for larger audiences than the traditionally registered students. In order to take optimal advantage of the new technologies, co-operation between academic institutions have turned out to be of benefit to all parties involved. Some practical examples and advances in this field will be presented. Experiences referred to are obtained by 4 Norwegian institutions at national level, later expanded to 8 European institutions in an international project. Organisational as well as pedagogical and subject related co-operation have turned out to offer valuable synergy effects, to the benefit of both staff and students involved.

Life Long Learning

1996 was declared the *European year for life long learning*, stating the fact that there is an increasing demand in all walks of life for updating and refreshing of existing knowledge and skills in order to keep abreast with professional and social requirements. Life in the information age and the knowledge society puts new demands on professional roles and performances. The technology itself changes the characteristics of traditional work, it also shifts the required skills for certain operations into completely different levels of understanding or detailed knowledge. Most professionals still tend to postpone the extra effort to embark on traditional continued education or in-service training programmes. The access to life long learning can be simplified by in-service training through the use of computers and electronic networks. European and national initiatives are launched in order to exploit these possibilities.

Cooperation between course providing institutions seems to be a fruitful track for saving efforts and resources. Partners may save much on development costs, administrative systems and infrastructure, and at the same time increase the quality of final products and offers to the target groups.

The role of the teacher or trainer is gradually changing from that of being a knowledge provider and a well of solutions to all problems, into being a guide or adviser for learners to find and choose from the information and instructional material already available. In a society where the amount of available information is growing exponentially, it is becoming increasingly important to assist learners in acquiring skills of information handling. An important part of this is to develop a critical and reflective way of sorting, discriminating and interpreting the information provided. Learners must also be able to turn the acquired information into knowledge and understanding of their immediate surroundings and the challenges facing them.

IT and Telecommunication

Particular requirements are related to new technology as part of new professional roles. ICT is not only a tool and a source of information, it is also in its own right an important part of workmanship and required skills of future citizens. It is accepted that a clerk expecting to maintain his work in these days must know how to apply word processing, and that an accountant will be obsolete if he does not know how to handle computer based accounting systems. It is recognised that a journalist or a history teacher must know how to search in databases for interesting extensions to his lessons on the present situation in the Middle East. It is equally important, however, for a social science or a biology teacher or an environmental adviser to manage system dynamics and simulation models in order to understand or communicate the challenges of local or global pollution.

Telecommunication seems to play an increasingly important role in future society. Networks with increasing capacity, band-width and speed of transfer for large amounts of digitised data, including sound and graphics, are covering greater parts of the world every month. From being a separate technology it is now accelerating its integration into computer and other information technologies, changing the PC from a stand-alone device into a node in a world wide network of information. Large databases are included in the same network and professionals of all kinds are meeting in the virtual space to discuss their problems and points of interest.

Open and Distance Learning (ODL) as a Tool to Cope with New Demands

The ever increasing demand for updated skills and knowledge in different fields makes it impossible to cover it all through traditional educational or training systems. Companies and public institutions have long traditions in arrangement of courses in-house or at hotels etc. when new skills or principles are introduced into their activities. No credits or formal qualifications were attached to most of these courses. It was part of the in-service training offered by the employer and required for updating on tasks to be performed.

An alternative for raising the qualifications of the staff is to let a selected few attend formal education programmes, acquiring new degrees or diplomas. Expenses related to such programmes can be born by the employer, by the professional her-/himself or as a joint agreement between the two parts. Costs are considerable for study programmes running over several years in order to obtain a degree, even in cases where the education or training is provided outside regular working hours.

Distance education has long been a practical way of taking courses and obtaining qualifications. Specialised providers like correspondence schools and open universities have offered thousands and millions of citizens interesting courses of initial and further education. In the age of new ICT it is natural to apply the technology for distribution of learning material. As a consequence of this the importance of distance in the learning process is changing. It is now becoming more essential to talk about *open* learning, possibly combined with learning at a distance into *open and distance learning*, ODL.

The definition of ODL varies according to organisation, structure and possibilities included. In this presentation we will stick to the interpretation where the *openness* is particularly directed to the *open access* of learning material through electronic networks. The *distance* of the students is not of the same importance to us; they may well be regular students inside the institution, staff members or individuals in another part of Europe. The important principle is that university courses, learning material as well as exercises and examinations are available to the learners in their part of the world. With certain restrictions the services should also be available to them when it is required, i.e. asynchronous distribution and availability is the general rule.

ODL makes career training accessible, costs and fixed working hours can be saved and the traditional universities and colleges may be opened to the public for life long learning programmes. The effort for traditional universities in order to change some of their traditional mass lectures and demonstrations into transferable, ICT-based learning material is quite a scary exercise. It may not even be possible or desirable in many cases, in particular subjects or topics. The latter is certainly the case for some of the special aspects, e.g. in training of nurses or in teacher education, where important values can hardly be detached from the human touch. There are, however, lots of topics and courses related to teacher and nurses training that may successfully be offered through ICT based ODL, and where positive results are already observed.

Challenges to Institutional Co-operation

The enormous efforts and resources needed for providing ODL material to new groups of learners simply require that parallel work and development of products should be avoided. All partners will benefit from co-operation instead of competition, exchange of material instead of protection, specialisation of competence instead of covering all fields at every institution, sharing of duties in stead of performing double work. In particular the learners will benefit from the products and facilities resulting from joint efforts.

There must be regulations and rules to play by, however. Models for co-operation between academic institutions for the purpose of ODL is being tried out in several European projects, providing valuable experience as a basis for revision of models and for development of new ways for obtaining ODL to the optimal benefit for both students, staff and the institutions involved. Most valuable results and experiences have been acquired when both academic institutions and receiving organisations have been working together in the planning and development of ODL courses and material. Examples of such activities will be provided in the following sections.

Co-operation between academic institutions is launched as an educational policy, nationally as well as internationally, including the establishment of educational collaborative networks between centres of higher education and research. Several European countries state in their White papers or other political documents principles and guidelines for exchange and sharing of expertise between educational institutions. As an example of how positive relations between institutions and exchange of experience are stressed, the European Commission's Socrates programme has *partnership between educational institutions* as one of their criteria for allocating funds to R & D projects. These are stated in the EU guidelines for proposals under the Socrates programme, 1996 & '97 [1].

Enterprises throughout the world state that there is a huge need for updating of professionals. To meet this need we already see a growing tendency of real co-operation between enterprises and the formal educational system in order to train their employees. Normally the employer has responsibility for updating their staff, but by now we more often see a combination of updating the staff by offering them formal qualifications. Development of necessary curriculum to obtain formal qualification is based on co-operation or joint ventures between companies and the formal educational system. The companies play a central role in describing the needs and also are the ones to find or provide the professional know how.

Introduction of electronic networks, e.g. Internet increases the functionality and facilitates practical activities among co-operating institutions. Both academic staff, learners and the outside learning society are supposed to benefit from diverse specialisation and expertise, sharing of duties between institutions.

Together, the collaborating institutions may become able to provide a greater variety of studies to their learners than any one of the institutions can manage on its own. Collaboration should emphasise the importance of being able to utilise the various profiles, specialities and professional expertise of the different institutions and enterprises. This should increase both the width and depth of the learning environment.

One example of how institutional co-operation is demonstrated at a national level by the NITOL project (NITOL = Norway-net with IT for Open Learning). Four academic institutions in Norway have successfully practised their own model of co-operation since 1994. Much of the success in this pilot project is probably based on long-standing relations and trust between the key personnel involved. The project's primary goals were to :

- gain experience and develop methods for ICT based, open, flexible and distance learning at university level
- facilitate co-operative research and development between geographically separated academic personnel.

In order to approach these goals partners chose to:

- establish an open network making education within Norway-net available to students and other groups and individual participants from business, schools, administration, etc.;
- gain experience on distribution of educational materials through electronic networks;
- test the use of electronic conferences, mail, and WWW as the basis for group work and co-operative learning;
- develop an extensive, dynamic and creative electronic learning environment based on local and wide area electronic networks; now practically done on the Internet and WWW.

Organising NITOL

Despite the close relations and friendship between the active partner representatives in the project, a formal organisation had to be established in order to be prepared for disagreements or conflicts that might arise over economy, responsibility for students, networks, software, academic property etc. The signed contracts are mostly

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dormant. In a few cases it has turned out very useful as reference and guidelines for disputes that arises. The project agreement is mainly in line with the project group's feeling of common sense, while the institutional contract is an important document when institutional authorities sometimes forget their commitments to NITOL.

Technical support and standards have proved to be important issues for ODL projects based on ICT. This always turns out to be a touchy issue between experts. Among the 'experts' in such a project there are tens of teachers and hundreds of students - who all have their own, well founded preferences for software and communication systems. On the other hand there are also many 'non-experts' or novices who need to be given simple solutions that fills their present needs. Among the latter group are also some of the course providers. It is therefore of outermost importance that the project group is able to make firm decisions, stick to the solutions given, and that there are able and committed people to support the technical system decided upon. As new technology develops and becomes available - outside the project - a careful balance must be found between existing, stable solutions and introduction of new, improved facilities for the project services. Responsibility for these technical decisions lies with the project group, while implementation and support is placed with one of the partners.

Objects of Collaborative Activities

Course Material

Together, the collaborating institutions are able to provide a greater variety of studies to their students than any one of them can provide on its own. The major advantage of collaboration is the exploitation of varied academic profiles and professional expertise, thus enhancing the curricula at both undergraduate and graduate levels, offering students and staff better professional environment. In addition, students may have a more flexible study programmes, working at the time and pace of their own choice, with few restrictions on attendance and location.

Because of the variety of professional profiles at the co-operating institutions, close collaboration strengthens the whole teaching and research environment at each institution. Through electronic communication it is possible to work together in a close and efficient manner in a "virtual" environment of co-operation. This has already been established between the NITOL institutions, and is spreading throughout the rest of the ODL environment. This is a system that effectively establishes and utilises contacts across the boundaries of institutions, regions and countries. Development of course material follows one of three different models for institutional cooperation:

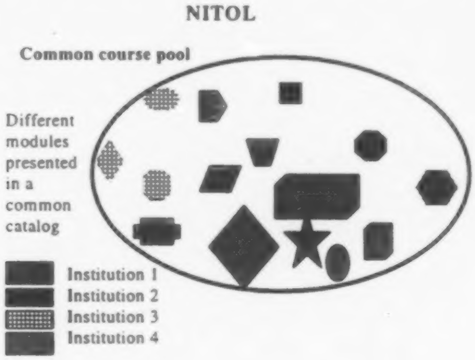

Figure 1: The open access model

The Open Access Model (Fig. 1) is one of several models within the NITOL activity. This was the first one tested, where each institution offered some of their traditional courses, revised or redeveloped for electronic transmission to their own students as well as to outsiders. The model is also applied sin some of the European ODL projects.

The beneficiaries of this model are mainly the students, who have easier access and more choices of courses. The institutions and the professors gain experience in dealing with distant students and the colleagues' ways of presenting learning material - a golden opportunity to have a look at how colleagues present and design their teaching material, is a fringe benefit.

The Composite Model is practised when institutions compose larger courses by joining two or more modules developed at different institutions.

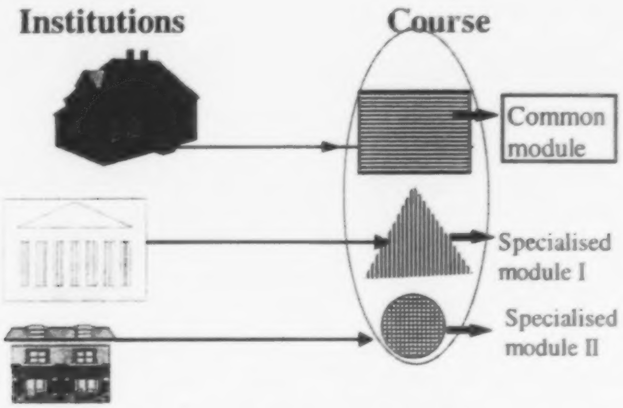
Institutions
Course
Common module
Specialised module I
Specialised module II

Figure 2: The composite model

The result could be a tailored study for special purposes or just an extension of a small course , which a single institution is not able to develop alone, due to restrictions on time, staff, expertise etc. This model seems to have value for colleges/institutions that are small or medium sized, where resources and the variety of the staff's expertise is limited. In the composite model, the institution responsible for the specific module, also takes full responsibility for the student activities within the actual module. Elaboration and marking of exercises are also a tried out as a collaborative, composite work, while assessment normally is done by one institution.

Joint Venture Model is a model where the main idea is continuos, real, close collaboration between the professors in joint development of course material. This means that two or more institutions within the network join forces in developing open, flexible learning material in the form of lessons.

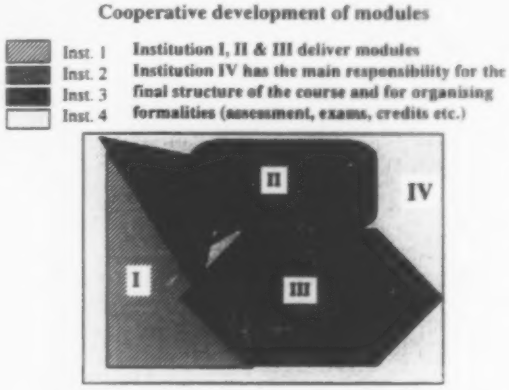
Cooperative development of modules
Inst. 1
Inst. 2
Inst. 3
Inst. 4
Institution I, II & III deliver modules
Institution IV has the main responsibility for the final structure of the course and for organising formalities (assessment, exams, credits etc.)
I
II
III
IV

Figure 3: The joint venture model

Several EU based ODL projects are practising similar principles and methods to organise co-operation across institutional as well as international boundaries. Some of these projects worth mentioning in this context are under the Socrates programme [2], e.g.

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- MECPOL - Models for European collaboration and pedagogy in Open Learning [3]
- Do ODL - Dissemination of Open and Distance Learning [4]
- EONT - an Experiment on Open learning using New Technology [5]
- DEMETER - Distance Education MEthods in Teacher Education and Research [6]

A first evaluation of collaboration, assessing the intentions and the models described, identifies characteristics like *inspiration* both to students and professors, *improvement* in the quality as well as an *increase* in quantity of the courses offered. Partners involved through NITOL, MECPOL etc. seem to be satisfied and inspired to further efforts for open and flexible learning

Mutual Services

An important issue in the partnership agreement is the mutual recognition of credits, courses and modules between the partners involved. Students may thus choose modules and courses from a larger menu, combining it into more varied and specially tailored lines of study. It is, however, still up to the institution that issues the certificate to recognise the final combination of subjects and courses

External funding has played a central role in the early stages of NITOL and MECPOL. Applications and proposals for funding have turned out to be more positively viewed in cases where a collaborative organisation is already established. Project partners have in several cases entered as one body in the process of making proposals and application, and afterwards shared the benefits obtained through decisions by the project group.

Instead of competing for the same target groups with parallel courses in related fields, the project groups have consequently, from the start, issued common course catalogues for all the courses provided by the particular project partners. Even though the courses are provided by individual staff members at separate institutions, and marked this way in the catalogue, there are great advantages in joint marketing. Distribution of information becomes easier, potential students get a better overview, and large scale customers, like the Navy, can find a more varied offering within the same context.

After less than 3 years the NITOL concept already has more meaning to a lot people interested in ODL, than the name of each of the partner institutions. At the same time, each institution benefits from belonging to this group. the European project groups have not yet obtained the same status, but hope to do so over time.

Visions

The models for ODL through telecommunication, taking advantage of the institutional operation described above, may provide easier access and higher flexibility for all kinds of professionals to obtain in-service and further education, as well as taking new formal degrees, without leaving their regular work/duties or their families. With the growing familiarity of Internet, telecommunication and similar facilities in homes and at work places, the time may soon be ripe for higher education modules to be available *when* and *where* each learner finds a need or a desire for them. This will require policy changes affecting the success of *lifelong learning*, both at national and international levels.

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[2] Book of Synopsis, ODL, Socrates, Projects 1995 & 1996; European Commission - DG XXII - Directorate A - Unit 4; SOCRATES & YOUTH Technical Assistance Office

[3] http://www.idb.hist.no/mecpol/

[4] http://www.idb.hist.no/doodl/

[5] http://hyperg.softlab.ntua.gr/EONT

[6] http://www.hsh.no/ lv/odlite/work1.htm

A Data Model for Educational WWW Servers

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Abstract: Although using HTML as a data exchange format in a client-server system is quite acceptable, and its platform independence has helped HTML to become the de facto standard today, use of HTML as a data storage format for WWW servers deserves examination so that a more useful model can be found.

In this paper we briefly describe a new data model, the HM Data Model, which offers far more advanced structuring capabilities than HTML. We believe that this more sophisticated model offers many advantages with respect to server management and user orientation.

We offer also a Formal method of mapping data structures based on HM-Data Model onto HTML documents.

1. Introduction

It is widely recognized that the Internet offers tremendous potential for education. For example, it is an excellent distribution channel for educational materials and courseware in particular. Normally, the term "dissemination of courseware over the Internet" refers to an interactive browsing of courseware using systems such as the World-Wide Web (WWW), the most well-known of the interactive information retrieval tools on the Internet.

HyperText Markup Language (HTML) is one of the main concepts upon which the World Wide Web is based. It provides certain capabilities: it provides facilities for describing how information should be displayed, it allows authors to include other forms of data in documents, (e.g. images, sound, pictures, etc.) and it lets them incorporate so-called computer-navigable links into documents. It is a markup language, meaning that it does not allow authors to specify exactly how the text will appear when it is rendered, but rather allows them to specify different basic elements of the text such as the level of heading. How the text is actually rendered depends on the machine it is being displayed on, and may appear different according to what fonts are available on that particular machine. To view WWW HTML documents, one of the many readily-available WWW browsers such as Netscape or Mosaic, which run on practically all hardware platforms, should be installed.

Normally, HTML is not just viewed by users using a client, but also is used to store documents on servers. Here, in contrast to the exchange of documents, it has a number of drawbacks.

Link anchors in HTML are embedded directly in documents, using so-called tags to mark the beginning and end of anchors. Using embedded links poses a number of problems in WWW documents. In particular, let us mention two the most well known problems related to the provision of courseware using WWW:

- First of all, references from one document to another are stored solely within the source document, making it impossible to follow links backwards or to find out what, if any, documents reference a given document. This leads us to the "dangling links" problem: often one must remove documents from WWW servers for one reason or another and the result often ends up being many links pointing to nowhere.
- Also, the lack of structure found in this simple data model is in need of much improvement. Thus, links in WWW are not context-dependent; all links in a document are present all the time. This has two major consequences.
    1. Firstly, the reuse of courseware materials is unsatisfactory, because an author can refer to other documents but cannot embed them locally with possibly new or different hyperlinks.
    2. Secondly, the presence of links completely unrelated to the current context (course) rapidly leads to reader disorientation.

The conclusion that can be drawn here is that although using HTML as a data exchange format in a client-server system is quite acceptable, and its platform independence has helped HTML to become the de facto standard today, use of HTML as a data storage format for WWW servers deserves examination so that a more useful model can be found.

In this paper we briefly describe a new data model, the HM Data Model, which offers far more advanced structuring capabilities than HTML. We believe that this more sophisticated model offers many advantages with respect to server management and user orientation.

We offer also a Formal method of mapping data structures based on HM-Data Model onto HTML documents.

2. The HM-Data Model

Current trends in logical data modeling can be classified into two main groups:

- Data models supporting links embedded within primitive nodes (i.e. links are local in the sense that they belong to individual documents);
- Data models supporting links as fully-fledged addressable objects (i.e. links are global in the sense that they belong to the hypermedia database as a whole).

In the HM-Data Model, information is not simply stored as HTML documents which have various references between them but rather is organized into units called structured collections (S-collections). An S-collection can be seen as a closed environment which contains a structure of navigable links between so-called Virtual Documents contained in it. Virtual Documents are documents which contain only information and not links. Virtual Documents contained in an S-Collection, are called members henceforth (see Fig. 1).

Thus, the HM-Data Model supports a third type of linking, conceptually somewhere in between the local and global link models. In the HM-Data Model, links neither belong to individual nodes (note that Virtual Documents are free of embedded links), nor they are globally addressable objects, but they are encapsulated within hypermedia containers called S-Collections. By definition, links cannot point outside an S-collection, but only between its members; hence S-collections represent well-defined chunks of information, which may be re-used in various contexts without concern for superfluous hyperlinks. The model compensates for the restriction of links to local contexts by introducing memberwise inclusion of hypermedia chunks and orthogonal browsing semantics to switch local context.

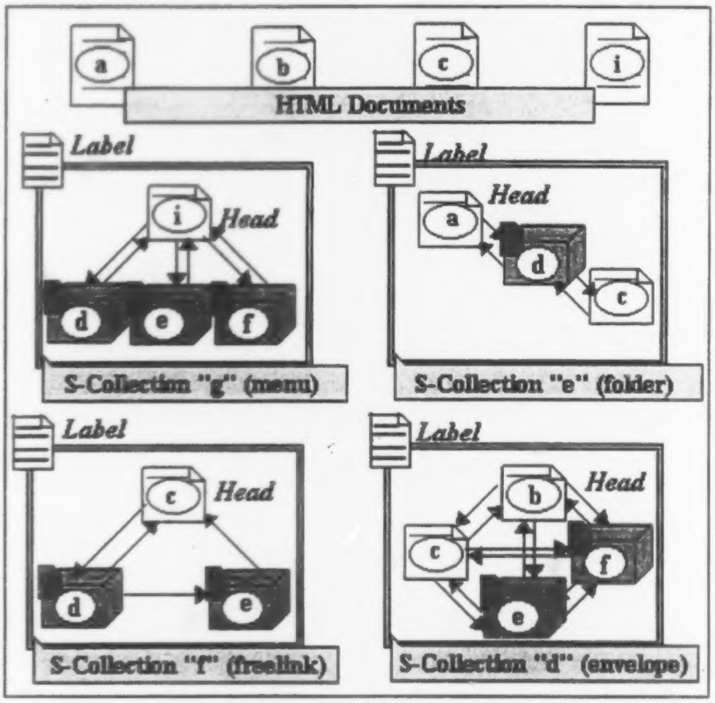

Figure 1: Internal Structure of S-collections

There are several predefined types of S-collection. An envelope has links back and forth between every combination of two members in the collection. A folder joins members into a list, with links to next and previous members. In a menu, one specific member (called the collection head) has links to and from each of the other members. Lastly, with freelinks, authors can link the collection's members in any manner they wish (see Fig. 1). Not only do menus have collection heads, but so does every other type of S-collection. The collection head is a member designated to be seen first when the user starts browsing an S-collection. This, as we shall see, is important with respect to the navigational mechanism in this paradigm. Also, an S-collection can have associated with it a label, a document which describes the content of that collection, and which is the first document seen when the user accesses the collection. These S- collections, which can be seen as separate containers in which only links between members of that container can be seen or followed, can also themselves be members of other S-collections and can have either other S-collections, Virtual Documents or both as members.

The nesting of S-collections can be arbitrarily deep. Recursive membership is possible, i.e. an S-collection can have itself as a member or contain another S-collection which has it as a member. Also, each collection is required to have a unique name which is used to support URL (Uniform Resource Locator) naming scheme. The name is used to access S-collections by means of WWW browsers and for specifying an S-collection for reuse (i.e. having the very same collection appear in two different S-collections and having it linked differently in each case). The reuse is possible as links are stored separately from virtual documents.

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There are three important navigational operations, which are called OPEN, CLOSE and ACCESS. The OPEN operation lets users do just that- when they have navigated to a certain S-collection, have read its label and would like to explore its contents, they open it. As mentioned earlier, each S-collection has a certain internal structure. When one is opened, the environment the user is in is switched from one collection to another. The internal structure of the opened collection is there for the user to browse, so until another collection is opened, the user can only navigate within this collection, always starting with the head of that collection (see Fig. 2).

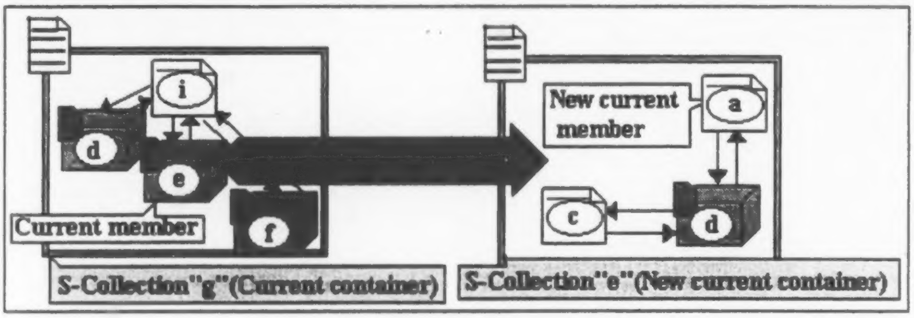
i
d
e
f
Current member
S-Collection"g"(Current container)
New current member
a
c
d
S-Collection"e"(New current container)

Figure 2: Operation "OPEN S-COLLECTION"

The CLOSE operation is the opposite of OPEN. It causes the user to leave the browsing environment of one collection and go back to the context of the collection in which it is contained. The third operation, ACCESS, is what the user uses to navigate between the members within a collection. It is similar to following a hyperlink, except that when users access a member of a collection, that member could be a virtual document or it could be another collection, and in this case, what they see first is its label, so they can decide whether to open it or access another member.

3. Projecting HM-Data Model onto the Web

As can be seen above, the HM-Data Model provides better structure and link maintenance than the data model currently used in the Web. If this model were used on Web servers it would save time and effort for server administrators and would also allow them to structure their data in a more advanced manner. It would eliminate the headache of link maintenance as this would be taken care of automatically. It would allow the same documents to contain different links in different contexts, allowing the reuse of information in various contexts. What we are suggesting is a union of the advantages offered by HTML and those of the HM-Data Model.

The idea is to use the advanced HM-Data Model to store information and to use HTML for that which it is well suited, i.e. the Mark Up and exchange of data. All that must be done here is to map the information and structure which is on the server onto elements that are well known in current Web terminology.

Virtual documents are prepared locally by means of an ordinary HTML editor and are stored into a special WWW server. Such virtual documents are further inserted into S-collections by means of a special authoring system running on the server site. S-collections can be accessed by a standard WWW client (for example, Mosaic, MS Explore or Netscape).

Thus, from users point of view, S-collections residing on the server can be treated exactly in the same way as conventional HTML documents. They are provided with URLs, and can be accessed and referred to from within other HTML documents. The only difference is that an S-collection encapsulates a particular navigational which is activated via an additional "Open" operation.

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4. Formal mapping of HM-Data Model onto Node-Link model

The following notation is used hereby to refer to navigational operations available in the HM-Data Model:
1. (**<S-collection>**) Each S-collection is put into brackets symbolizing a closed navigational system of the S-collection;
2. → This symbol denotes the ACCESS operation in HM-Data Model
3. (→ This symbol denotes the OPEN operation in HM-Data Model
4. ↑) This symbol denotes the CLOSE operation in HM-Data Model

The following infer rules can be used by a software component (i.e. Gateway) converting a database structured in accordance with the HM-Data Model, into conventional HTML documents.
1. <Database> ::=<label>(<S-collection>)
2. <S-collection> ::=<folder>
3. <S-collection> ::=<menu>
4. <S-collection> ::=<envelope>
5. <folder> ::= <member$_1$><member$_2$>...<member$_n$>

6a. < member$_1$> ::=< member$_n$> | < member$_2$>

6b. < member$_2$> :: =< member$_1$> | < member$_3$>

6c. < member$_n$> ::=< member$_{n-1}$> | < member$_1$>

7. <menu> ::=<menu_head>
8. <menu_head> ::=<head><menu_member>
9. <menu_member> ::=<member><menu_head>
10. <envelope> ::=<envelope_member>
11. <envelope_member> ::=<member><envelope_member>
12. <head> ::=<label>(<S-collection>) | VirtualDocument
13. <member> ::=<label>(<S-collection>) | VirtualDocument
14. <label> ::=VirtualDocument

5. An Example

Let us consider the following user session. Suppose the user accesses the S-collection "g" (see Fig. 1) using a known URL. The label of the S- collection (i.e. the virtual document) is automatically converted to an actual HTML document by means of embedding additional navigational means (button "Open" in this particular case) , the resultant HTML document is displayed on a client site. Whenever the user "opens" the S-collection "g", head of the S-Collection "g" (i.e. document "i") is automatically converted to an actual HTML document by embedding menu of (i.e. links to) all the members. Suppose, the user activates the link to the member "e" which is in turn a complex collection. The S- collection "e" becomes the current member, and a virtual document defined as its label is displayed with a corresponding link to "I" and an additional anchor "Open". Now the user is able to "open" this S-collection "e". Once the S- collection is "opened" the head (i.e. document "a") enhanced with links encapsulated within the current container becomes available. Now the user may "close" the S-collections "e" and "g".

The sequence of operations generated by the above discussed rules may look as follows:

<Database>→<Label>(<S-collection>)

→VD-Label-g(<S-collection>)

→VD-Label-g(→<menu>)

→VD-Label-g(→<menu_head>)

→VD-Label-g(→<head><menu_member>)

→VD-Label-g(→VD-i<menu_member>)

→VD-Label-g(→VD-i→<member><menu_head>)

→VD-Label-g(→VD-i→VD-Label-e(<S-collection>)<menu_head>)

→VD-Label-g(→VD-i→VD-Label-e(→<folder>)<menu_head>)
→VD-Label-g(→VD-i→VD-Label-e(→<member_1><member_2>...<member_n>)<menu_head>)
→VD-Label-g(→VD-i→VD-Label-e(→Vd-a<member_2>...<member_n>)<menu_head>)
→VD-Label-g(→VD-i→VD-Label-e(→VD-a↑)<menu_head>)
→VD-Label-g(→VD-i→VD-Label-e(→VD-a↑)<head><menu_member>)
→VD-Label-g(→VD-i→VD-Label-e(→VD-a↑)VD-i<menu_member>)
→VD-Label-g(→VD-i→VD-Label-e(→VD-a↑)VD-i↑)

6. Conclusion

As can be seen, the data structure which is currently widely used in the Web is not nearly as advanced or useful as it could be. There are many well-known problems which are encountered when using HTML for storing data on servers. Still, HTML, with its platform independence, is excellent for the exchange of data between server and client. We believe that the HM-Data Model could provide and new and useful paradigm which would eliminate the problems caused by the fact that HTML documents have links embedded in them. Using each model for that for which it is best suited seems like an ideal solution to many of the problems of the Web today. This idea could be accomplished by mapping the rich structure of the HM data model onto the simple node-link paradigm found in HTML.

HM-Card, a software package that implements this model, as well as help files and a number of courseware examples are available from: http://www.iicm.edu/hmcard

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Structuring Web Documents:
Are Multimedia Guidelines Useful to Web Designers?

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Abstract: This paper presents a report and discussion of a study completed by the author in May 1995 at the Faculty of Educational Technology at the University of Twente. Design guidelines for development of instructional multimedia documents were selected through a literature review. The guidelines were subsequently ranked by importance after testing their applicability on four commercial multimedia publications, including an analysis of the products' underlying design criteria. The five most important design tips for structuring multimedia documents were annotated in an interactive program for students of instructional design whose assignment was to develop programs using multimedia. The focus of this paper is to connect hypermedia research to the World Wide Web and uncover how many of the multimedia design guidelines pertaining to navigation are now standard features of web browsers; to identify which multimedia design criteria can be useful to Web designers; and to explore which guidelines for the development of good multimedia documents can assist in creating consistently-structured materials for the World Wide Web.

Introduction

Even though there are few design guidelines for structuring multimedia projects, complex compound documents that might include an interactive user interface, graphical images, hypertext, sound, animation and video are being developed, in great numbers, for a variety of display platforms.

With innumerable World Wide Web servers now containing hyper-linked materials, the question arises whether some of the guidelines developed for hypertext and multimedia documents can be useful to a "Web designer". On the Web, some of the features an author might wish to implement are incorporated in the browser software: by moving responsibility for document display from author to viewer, the author is left with less influence on a document's design.

This paper describes how a set of design guidelines for structuring multimedia documents was extracted from literature, reviewed in the context of commercial CD-ROM products, and used to develop an interactive program designed to help educational technology students structure their first multimedia documents. The discussion concentrates on how well, if at all, the guidelines useful to multimedia designers can help authors structure their materials for the Web.

Method and Procedure

The Literature Review

Eight recent articles [Horn (1993), Horton (1994a-c), van den Meiracker (1994), Rockley (1994), Smith, Munson, Lightner and Gregg (1994) and Webster (1994)] were reviewed for design guidelines useful to instructional designers embarking on development of multimedia projects. Five main design ideas were selected from each article and subsequently used as a 40-item checklist for evaluating the underlying design criteria of four published multimedia products. [Short reviews of all articles can be obtained from the author.]

The Product Review

Four commercial products, published on CD-ROM [Apple Computer (1994), MacWorld (1994), Maltwood Art Gallery (1994) and Norman (1994)] were scanned for compliance to the 40 guidelines described earlier. During the product review, screens that exemplify some of the 40 guidelines were saved, compared, ranked and used to select five of the most important design considerations found in current multimedia products that can be supported by recent literature. These five "tips" formed the foundation for an interactive learning aid developed for first-year students given the task to design multimedia documents.

Interactive Demonstration of Guidelines

A hypertext program "*Design Tips*" was subsequently developed (in Hypercard for the Apple Macintosh computer) to illustrate the design concepts in an interactive way: the program was designed to be used as both a model and a resource for a course on On-line Learning offered by the Faculty of Educational Technology at the University of Twente. The program's design incorporates 15 of the original 40 guidelines first identified in the literature, pertaining to navigation, content and visual design. The program was limited to five tips due to the time constraints of the project, but designed in a modular way for adding more guidelines at a later date.

Results

Five main design ideas from eight articles resulted in a 40-item checklist used to rank the five most important design criteria, supported by current research, that were applied in the four selected multimedia publications. A hypertext program incorporates the criteria in an interactive learning tool for students developing multimedia documents.

The Guidelines

The literature and product review yielded the following, most important design considerations:

1. To provide materials in small information units that are easy to navigate

Information should be presented in manageable, consistent information chunks in easy-to-read typeface and colours; with every screen displaying (in the same location, and in a similar colour and size) "Help" and "Quit" options, as well as "Forward" and "Backward" buttons for an alternative, linear path through the document.

2. To reveal the information in increasing levels of detail

It is better to allow the viewer to select more detail than to present more information than necessary on one screen: use of inserts and expanded views in any form such as tables, photographs, animation, and graphics can add the necessary level of detail on demand.

3. To focus on substance and avoid inundating the viewer

Technology should not overwhelm the substance of the presentation, and art and design criteria should be subordinated to the objective. Overloading screens with uninformative lines, boxes, decoration, or colour is confusing: superfluous detail should therefore be avoided.

4. To provide an overview of the contents

An interactive list of contents should be designed with each level leading to a lower level providing more detail. References to numbered screens (which are analogous to page numbers in a print-based document) are not necessary in an interactive list of contents since selecting a topic will display the pertinent information. For small projects it is sufficient to design a screen that clearly lists the main points the program can access.

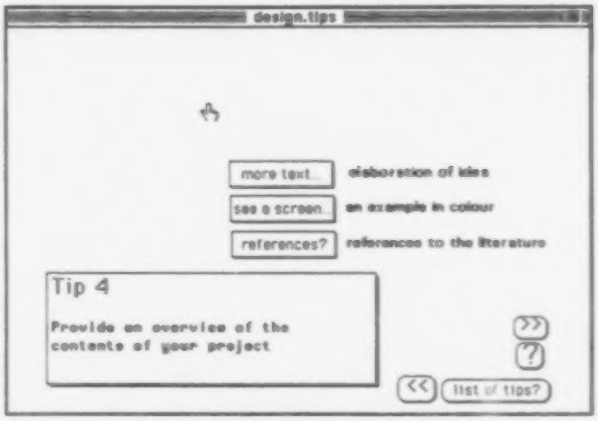
5. To index the information

When the program is complex, an index seems indispensable. To be able to access the information by keywords and by screen number helps those users who know what part of a program they wish to access and who might resent having to work through layers of screens, menus or information windows to get there.

The Interactive Program to Demonstrate Guidelines

The hypertext program "*Design Tips*", in addition to incorporating 15 of the original 40 guidelines to illustrate 5 design criteria, presents a total of 24 screens of information on a grey-scale image background; provides 17 buttons which access 155 navigational links (of which 61 are generic and 94 are contextual); and provides buttons that display 84 associated fields of text and 5 graphic colour images. Two screens of "tip 4", *explanation* and *elaboration*, can be seen in Figures 1 and 2 below (the background design is omitted).

Figure 1

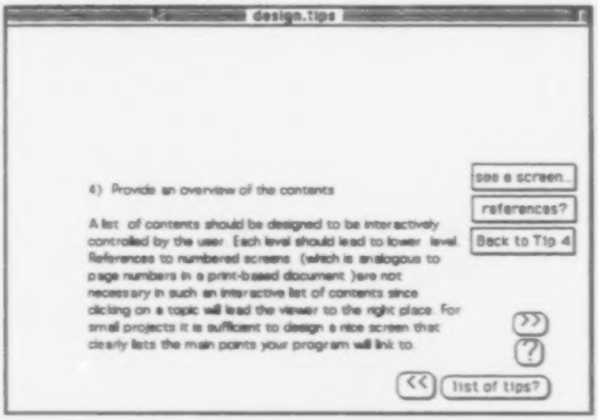


Tip 4

Provide an overview of the contents of your project

Figure 1: Tip 4 Explanation

Figure 2



4) Provide an overview of the contents

A list of contents should be designed to be interactively controlled by the user. Each level should lead to lower level. References to numbered screens (which is analogous to page numbers in a print-based document)are not necessary in such an interactive list of contents since clicking on a topic will lead the viewer to the right place. For small projects it is sufficent to design a nice screen that clearly lists the main points your program will link to.

Figure 2: Tip 4 Elaboration

Contextual Navigational Links

The program displays each of the top five design tips as a small unit of information. Hypertext links can be made to three levels of depth: (a) for elaboration—to view explanatory text, (b) for an example—to view a screen captured from a reviewed multimedia product, and (c) for further study—to view reference materials. These links are contextual links, based on the information content.

The contextual buttons are always placed in the centre horizontal band of the screen and are represented by square rectangles. In addition, main menu choices are also centred in the vertical band of the screen, while other choices appear on the right hand side above the generic buttons (described below) to reduce unnecessary mouse movements.All contextual buttons have associated fields of text, while the "example" buttons have associated graphic images. All fields have been locked individually to prevent changes and are displayed in consistent fonts, font sizes and attributes.

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Generic Navigational Links

In addition to the contextual links, generic navigational links are provided: a "Forward" button provides a linear path through the information while a "Rewind" button presents the information in the order accessed by the user (on a last-in, first-out basis). The generic buttons appear on every screen provided they are appropriate (no "Forward" button is placed on the last screen, for example). These buttons are oval rectangles and always appear in the same position in the lower right hand side of the screen.

A "Help" button provides on-line help (which returns to the section where help was called from, upon activation of a "Done" button). A "List of Tips" button returns to the main menu screen. A "Stop" button ends the program when called from the main menu, an "End" button terminates the program when the last screen (credits) is reached. In addition, a "Start" button has been built in, its sole purpose being to provide a link that can connect future additions of new modules.

Discussion

How pertinent are the above design guidelines to the Web since they were devised for multimedia publications, which are self-contained and can be controlled by the authors? Web documents, on the other hand, might be stored on a variety of servers, are accessible from multiple sites, with document display controlled by the viewers or the settings of their access software (the browsers) rather than controlled by authors.

Options now Handled by Web Browsers

Some of the multimedia design guidelines pertaining to navigation are now standard features of web browsers: The user can determine what typeface and colours are easy-to-read; every screen displays, on the toolbar and in the same location, a "Stop" option, "Forward" and "Back" buttons, as well as an option of returning to the "home page" (the initial screen analogous to the main menu). The standard buttons, however, neither provide on-line help nor a linear path through the document, a feature anyone who has tried to print a complete, long Web document would have appreciated.

Criteria Applicable to Web Documents

A still applicable, and most important, design guideline for structuring Web materials is the requirement that information be presented in small information units: the method of Structured Writing described by Horn, (1993) which was developed 25 years ago, can still act as a guide for providing the, often missing, structure and consistency for a Web document. Information blocks, identified by a descriptive label, replace traditional paragraphs as logical units describing core parts of a limited topic. Each block forms part of a larger structure which collects all items related to a specific topic. Classification of contents and formulation of precise labels help the author to clarify the concept and the reader to anticipate, scan and find the information.

Another important guideline, since it saves band-width as well as reducing time users might need to wait for, possibly irrelevant, information, is the rule to reveal the contents in increasing levels of detail: opening a link in an ordered list, for example, can provide an expanded view of an item in context; clicking on an image map can provide detailed illustrations; providing thumb-nail graphic images in low resolution can help the viewer determine if down-loading the full picture is appropriate.

A guideline that appears to be unnecessary since viewers (instead of authors) control the screen display, must, nevertheless, be mentioned again: the need not to clutter valuable screen space with superfluous detail such as background textures, illegible text colours, excessively-complex tables and moving text or images: such tactics are often apparent at commercial sites. While it is pretty easy to avoid clutter by turning off the display of graphic images or using a text-only browser, by site designers following this guideline they might regain viewers who, disturbed by overload, tend to avoid a cluttered site.

Since building an index for full-text retrieval can be tedious in multimedia documents, especially when components such as video clips have to be linked in manually, see Rockley (1994), index building is only advisable for complex programs. On the other hand, making a Web document searchable requires only one HTML command which should therefore never be omitted.

Ideas Suitable if Modified for the Web

The multimedia design guideline to generate a "table of contents" which can be accessed interactively is easily incorporated into Web documents. By displaying links in one of the HTML list structures (such as menu, ordered, standard, unordered or definition lists) and by assigning meaningful labels to the items in the list, list structures can act as implicit tables of contents.

The suggestion to reference screens by numbers, on the other hand, is illogical in a Web setting, since screens are not of a fixed size but contain varying levels of information depending on the preferences set in the browser. This idea has been carried over from books and a better method and analogy must be found to visualize where a screen of information is positioned in the context of a complete document.

Further Research

Designing for the World Wide Web presently still appears to be more of an individual (and cumbersome) rather than a collaborative task, difficulties in finding a common ground for collaboration are more likely to be overcome if more research becomes available on what "works" and what does not, especially if the software developers apply this knowledge to develop better and easier-to-use tools. Evaluation of user preferences; of content accessibility; of browsing and authoring tools, and their user interface; and research linking hypermedia knowledge to emerging web standards are areas where much work remains to be done.

Conclusion

This paper has briefly considered how design guidelines found in literature for multimedia projects can be applied by educational designers presenting materials on the World Wide Web. The concern with design aspects of the Web are important due to the necessity of having to organize massive information of varying types, and across locations; the difficulty of the task of displaying the information on (rather limiting) flat screens; and the requirement of having to provide links to the information spaces in a logical, easily visualised, and consistent manner.

On the Web, addressing the need to provide tools for search, visualisation and display of the information is in the software developers' domain; addressing the need to provide contents and structure is in the authors' domain: neither can succeed if those seeking out Web documents cannot find the information, consider it useless, or consider the access tools unusable. To work collectively on identifying and resolving usability issues continues to be critical.

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The Learning Web in the Workplace

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Abstract: Workplace learning provides a rich environment for investigation of the *learning web* approach since it involves learners with well-defined job roles collaborating in goal-directed activities. There are not only general learning needs in order to fulfill the roles but also highly focused 'just in time' knowledge and skill requirements. This article reports on an initial experiment to integrate the workplace learning environment with the ongoing workplace activities in such a way that the support of learning is an integral part of the organization's primary activities. It focuses on providing a group communication and negotiation environment in which the specialist roles of the individuals involved are modeled within the system and are explicit in the interactions and services involved.

1 Introduction

The learning web has been introduced as a model for collaborative learning through self-organizing communities operating through distributed networks that transcend conventional institutional, regional and national boundaries (Norrie and Gaines, 1995; Gaines, Norrie and Shaw, 1996), and examples have been given of its implementation for undergraduate education (Shaw and Gaines, 1996). However, the transformation expected in adult education through the learning web approach can best be illustrated through learning environments that are not confined to existing educational institutions but address issues of lifelong learning through the support of individuals and groups operating in the workplace.

The workplace learning environment differs from that of the university because those involved have well-defined functional job roles supporting the objectives of the organization of which they are part. Their learning needs arise out of the adaptive processes entailed by their roles, and are often highly focused on particular 'just in time' knowledge and skill requirements. There are also longer term, transformatory learning requirements as roles and job requirements change that can be satisfied by conventional education and training courses, but the workplace environment has a major emphasis on learning linked to immediate needs and to the support of goal-directed group processes.

The learning web models addresses these more diverse requirements of workplace learning through a unified model that recognizes *communities of knowledge* (Shaw, 1985) and adopts a *collective stance* (Gaines, 1994) which treats organizations and teams as learning individuals similar to individual people. The learning needs of work groups and individuals are modeled as resulting from the recursive sub-division of the organization into partitions similar to the organization as a whole—a model similar to Warnecke's (1993) *fractal company*.

Thus, we do not see the support of workplace learning as being primarily a problem of 'distance delivery' of conventional adult education courses, although that can certainly play a significant role. The significant requirement that differentiates workplace and university education is to integrate the workplace learning environment with the ongoing workplace activities in such a way that the support of learning is an integral part of the organization's primary activities. This article reports on an initial experiment to achieve such seamless integration using the learning web approach. It focuses on providing a group communication and negotiation environment in which the specialist roles of the individuals involved are modeled within the system and are explicit in the interactions and services involved.

2 Requirements Negotiation as an Example of a Generic Workplace Activity

The task chosen as providing a reasonably generic instance of a common organizational function was that of negotiating system requirements between various 'problem owners' and 'system developers' within the framework of Checkland's (1981) *soft systems methodology*. This situation is a common one in all organizations and usually involves learning on the part of both the system specifiers and the suppliers as both groups adapt to one another's needs and capabilities in a dynamic environment. There are two major approaches to what has come to be called *requirements engineering*, that of *participatory design* (Schuler and Namioka, 1993) and that of *joint application design* (August, 1991), and the system supports both approaches.

The general roles defined for the requirements negotiation task are:

- the *facilitator*, who acts as a chairperson of the meeting
- the *users*, who are people involved in using the system, are the "owners" of the problem.
- the *analyst*, who transfers the requirements from the "problem owners" to the design team.
- the *design team*, who are the system implementors, are responsible to meet the elicited requirements.

Other examples of the learning web in action (Shaw and Gaines, 1996) have used the standard facilities of the World Wide Web, sometimes supplemented with constructivist modeling tools operating through the web (Shaw and Gaines, 1995). For the workplace studies we needed tools that explicitly supported structured collaboration in a way that was not yet available on the web, and chose to use the TeamRooms system (Roseman and Greenberg, 1996) which is implemented as an Internet or intranet application using the groupware toolkit GroupKit (Roseman and Greenberg, 1992).

TeamRooms combines shared whiteboards, chat rooms and other customizable groupware applets (integrated mini-applications) in a persistent work environment that lets participants easily and flexibly collaborate and share information with colleagues across a network. The model for TeamRooms comes from real-life team meeting rooms, which provide a shared space for a workgroup. TeamRooms works the same way, except that the room and its objects are now a fully graphical, persistent groupware interface.

3 TeamRooms as a Negotiation Place for Requirements

The first step in customizing TeamRooms to support a learning web concerned with requirements negotiation was to analyze the roles of the major participants using Checkland's soft systems methodology as shown in the concept map in Figure 1.

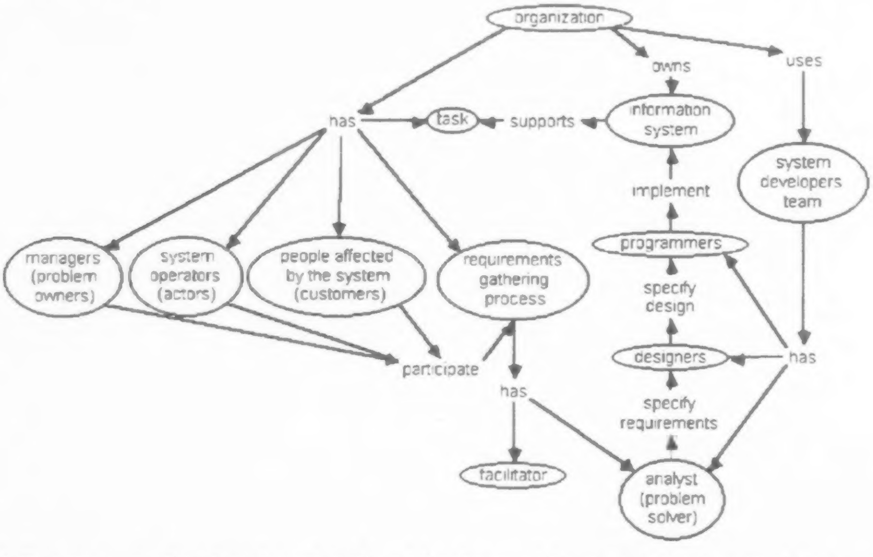
organization
owns
uses
has
task
supports
information system
implement
system developers team
programmers
managers (problem owners)
system operators (actors)
people affected by the system (customers)
requirements gathering process
specify design
designers
has
participate
has
specify requirements
facilitator
analyst (problem solver)

Figure 1 Concept map showing the roles played by the participants within the organization and the requirements negotiation process, according to Checkland's soft systems methodology

Then a set of virtual rooms was defined to support the types of interaction that would be required by participants having these roles. They have been grouped in four areas. The layout of rooms in supporting the iterative requirements negotiation process is illustrated in Figure 2.

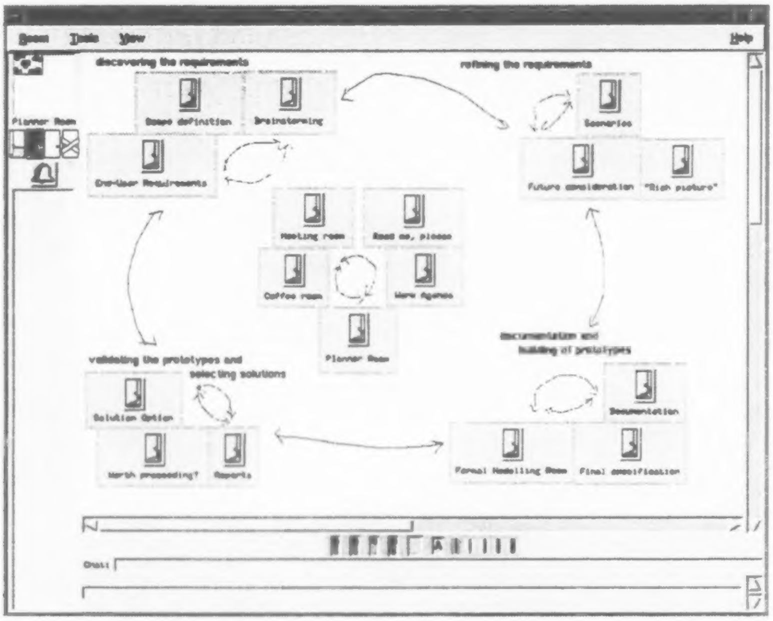
Room
Tools
View
Help
discovering the requirements
Planner Room
Scope definition
Brainstorming
End-User Requirements
refining the requirements
Scenarios
Future consideration
"Rich picture"
Meeting room
Read me, please
Coffee room
Work Agenda
Planner Room
validating the prototypes and
selecting solutions
Solution Option
Worth proceeding?
Reports
documentation and
building of prototypes
Documentation
Formal Modelling Room
Final specification
Chat:

Figure 2. The layout of rooms in the iterative cycle of requirements negotiation

The requirements negotiation process is about navigating this electronic workspace. The participants enter any of these rooms by clicking on the "door" of any room.

4 Collaboration in the Electronic Workspace

Awareness of other users in the work space is very important in simulating the real physical space. The list of users currently connected to the group's server, as well as the room each user is currently working in facilitates locating the other users and making contact with them.

The facilitator, who acts as a chairperson of the meeting, has a critical role in organizing the work of the requirements negotiation team. She enables effective communication, works as a project manager for the elicitation team, can have the knowledge of the room and action of each participant in the working space. She can use the **Work Agenda** Room to organize the work through an agenda of the meetings and lists of activities, using the Outliner or the Note Organizer applets to create a hierarchical activity structure, or a Concept Map applet to identify and set priorities.

Figure 3 illustrates the **Future Consideration** Room, a "storage and future retrieval" area. Exploring the users' environment, the capture team collectively investigates the target users' organizational setting and identifies and describes what they do. They produce documents recording the shared view of the users' environment. They create objects reflecting the users' workspace and save them in a database. Records in this database are files containing information that describes these specific objects. Users of the system may retrieve these files using the File Holder tool. Any file editor would give the participants the opportunity to read and modify the content of the files, after they discussed the changes with the others in the room.

The **Documentation** Room may be used by the analyst to record the elicited requirements. Documenting the elicitation process may be a time consuming task in usual physical meetings. Using the **Documentation** Room in the electronic space, the analyst records all information that participants generated, all the analysis conducted, all of the decisions reached, in hypertext format, creating the requirements documents. This way the documentation files have a higher quality, they are easier and more quickly produced. Validating

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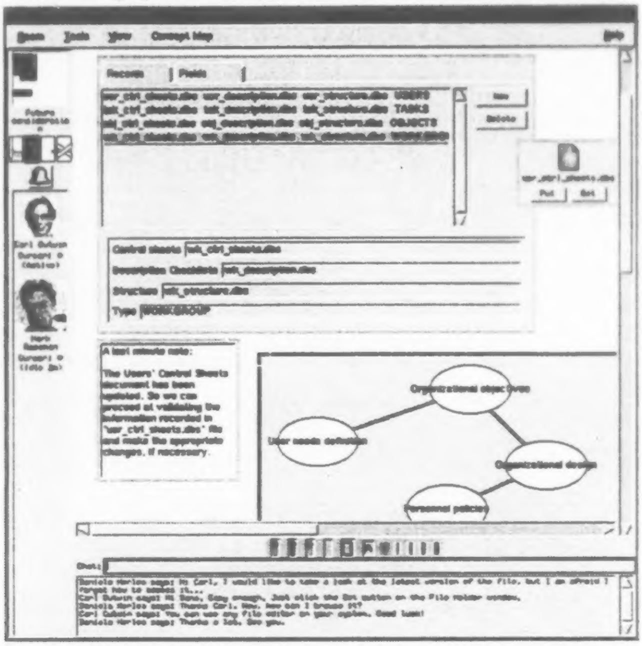
understanding of the user environment with the system customers and end users, and formulating requirements based on this existing "picture" may be done in the **Worth Proceeding?** Room (Figure 5).



Room
Tools
View
Concept Map
Help
Records
Fields
New
Delete
usr_ctrl_sheets.dbs
Put
Get
Future considerations
Carl Gutwin
Cursor: 0
(Active)
Mark Roseman
Cursor: 0
(idle 2m)
Organizational objectives
User needs definition
Organizational design
Personnel policies

usr_ctrl_sheets.dbs usr_description.dbs usr_structure.dbs USERS
tsk_ctrl_sheets.dbs tsk_description.dbs tsk_structure.dbs TASKS
obj_ctrl_sheets.dbs obj_description.dbs obj_structure.dbs OBJECTS
wk_ctrl_sheets.dbs wk_description.dbs wk_structure.dbs WORKGROUP

Control sheets wk_ctrl_sheets.dbs
Description Checklists wk_description.dbs
Structure wk_structure.dbs
Type WORKGROUP

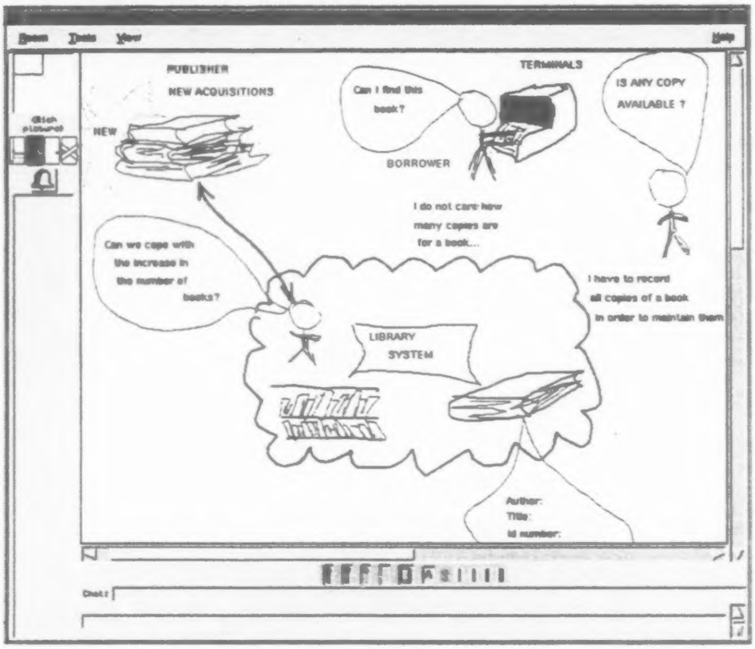
A last minute note:

The Users' Control Sheets document has been updated. So we can proceed at validating the information recorded in 'usr_ctrl_sheets.dbs' file and make the appropriate changes, if necessary.

Chat:

Daniela Herlea says: Hi Carl, I would like to take a look at the latest version of the file, but I am afraid I forgot how to access it...
Carl Gutwin says: Hi Dana, Easy enough. Just click the Get button on the File holder window.
Daniela Herlea says: Thanks Carl. Now, how can I browse it?
Carl Gutwin says: You can use any file editor on your system. Good luck!
Daniela Herlea says: Thanks a lot. See you.

Figure 3 A "storage and retrieval" room for the user environment's objects



Room
Tools
View
Help
Rich picture
PUBLISHER
NEW ACQUISITIONS
NEW
TERMINALS
Can I find this book?
BORROWER
IS ANY COPY AVAILABLE ?
I do not care how many copies are for a book...
Can we cope with the increase in the number of books?
I have to record all copies of a book in order to maintain them
LIBRARY SYSTEM
Author:
Title:
Id number:
Chat:

Figure 4 The "rich picture" of the problem situation being investigated

The **"Rich Picture"** Room is used to build the 'picture' of the situation being investigated. In the framework of the *soft systems methodology*, it is the pictorial form that shows the main structures and the pattern of formal and informal communication. The reason for drawing pictures and diagrams is that human affairs

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reveal moving pageant of relationships, and pictures are a better means for recording relationships and connections than in linear prose (Checkland and Scholes 1990). The example used in describing the content of these rooms is from a requirements negotiation process for a library system.

As a next step, an initial list of requirements may be proposed and stored in a generic "wish list", in the **"Wish List"** Room. The list of contents for a set of issues related to the requirements document is stored using the Outliner tool that helps in analyzing the information. It enables users to build upon a previously generated list and refine it into a hierarchical structure. In their "discussion" participants are helped by telepointers. They can see the other's cursor location on the document. In face to face meetings, hand gestures play an important role to communicate ideas. Telepointers are examples of a fine-grained awareness of others' actions in the workspace.

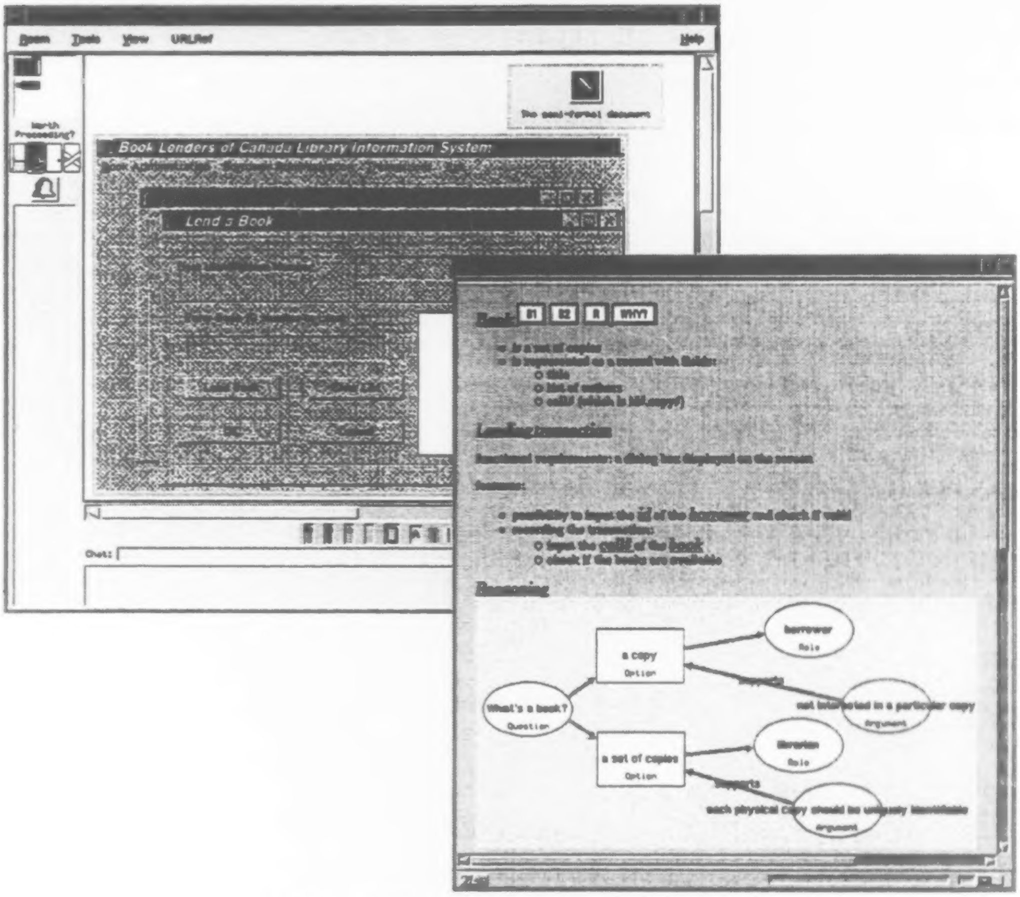
Room Tools View URLRef
Help
Book Lenders of Canada Library Information System
Lend a Book
Chat:
a copy
Option
borrower
Role
What's a book?
Question
supports
not interested in a particular copy
Argument
a set of copies
Option
librarian
Role
supports
each physical copy should be uniquely identifiable
Argument

Figure 5 Checking the accuracy of requirements

Figure 5 illustrates the screendump of a lending transaction prototype. The image tool has been used to retrieve it. Participants in the process use it in checking the accuracy of the elicited requirements; they use a Web browser to retrieve the requirements documents.

5 Conclusions

The system described is an initial experiment in using the learning web approach to provide a system that integrates the workplace learning environment with the ongoing workplace activities in such a way that the support of learning is an integral part of an organization's primary activities. TeamRooms provides the facilities to make available a wide range of resources in a structured environment that recognizes and supports the specific job roles of the participants. Some of these resources will be the products of the ongoing activity. Others will provide access to knowledge that supports the 'just in time' learning necessary to carry out the

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activity effectively—these will look like 'information retrieval' facilities. Other resources will provide access to background materials necessary to operate more effectively in the roles—these will look like 'education and training' facilities. However, from a user perspective these differences will not be particularly significant because they will see the entire system as supporting their ongoing activities in a seamlessly integrated fashion.

The requirements negotiation process was chosen because it is of particular interest to our industrial sponsors and it is also a reasonably generic activity that occurs in most organizations. However, support of workplace learning can be integrated with virtually all activities that can be supported by a computer-based system. As 'workflow' support systems (White and Fischer, 1994) come to be common in industry they will also come to serve as vehicles for the delivery of workplace learning. As many learning needs are common across many industries, we may expect to see the *electronic data interchange* (EDI) paradigm extended to one of *electronic learning exchange* (ELE) in which the specialist training materials of one organization are provided to others to facilitate collaboration or as a revenue source.

Acknowledgments

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URL's for Materials

TeamRooms: http://www.cpsc.ucalgary.ca/Redirect/grouplab/
Related articles: http://ksi.cpsc.ucalgary.ca/articles/

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Specification and Implementation of an Adaptable Virtual Class

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Abstract. This paper describes a virtual class which is based on the principles of CSCW (Computer Supported Cooperative Work) and ICAL (Intelligent Computer Aided Learning) systems. The virtual class proposed allows to a group of learners to participate in training sessions of an adapted tele-teaching system or adapted virtual class, this system takes into account progression rhythm differents inside a community of remote learners. The virtual class allows to adapt the teaching system in a flexible, individual, and collective way. This system allows also the implementation of a pedagogical method: the cooperative learning. This implementation is developed in a distance education context using a telematic network. An application of this system in a multi-site environment of teaching of the accounting domain is described. The development of this system has been realized as a distributed application, the system of development used is the RPC (Remote Procedure Calling) product and the C and C++ languages.

I Introduction

The principle of the architecture proposed for an adapted training service is to allow the adaptation of knowledge transmission from a teaching function managing a virtual group of learners by a communication system (figure 1). Teaching functionalities are distributed taking into account the participation of teachers, system, resources and learners in some cases (when a learner has the knowledge or experience necessary for playing the teacher's role).

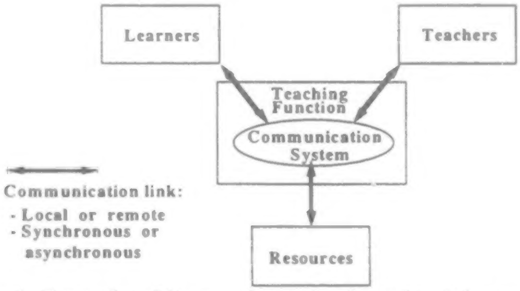

Figure 1: General architecture for each adapted training service.

The majority of learning telematic systems developed do not or rarely enable the system to control the teaching module. In general this function is controlled by the teachers, in the same way as traditional classrooms. In this paper, we propose for each adapted training service that the system allows to distribute the teaching functionality with the participation of teachers, learners and resources in a virtual class system.

II General Architecture

In the multi-site environment of tele-teaching, we propose that any training site must be represented according to the ARESFED (In french: "Architecture pour la Reutilisation et l'Exploitation des Services de Formation dans le contexte de l'Education à Distance") [Hernández 95d]. This architecture is composed of three layers: support layer, layer of a set of reusable SITB (Service Independent Training Building Block) and a cooperative services layer [Hernández 94c], [Hernández 95c], [Hernández 95d] (figure 2).
In this way, the representation of each training site is simplified and standardized. Thus, we must specify only an architecture: the ARESFED.

II.1 Support Layer

It represents a set of frameworks from which the training architecture is built:

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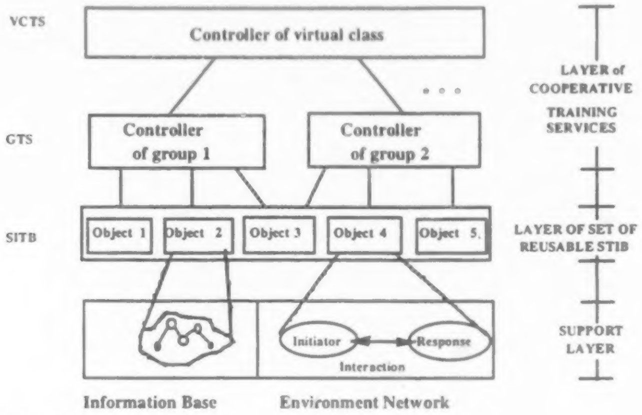
Information Space, provides information management services relevant to the courseware developed (for example: an object-oriented database management system stocks all the reusable objects).



SITB: Service Independent Training Building Block
GTS: Group Training Service
VCTS: Virtual Class Training Service

Figure 2: Training architecture of a virtual class.

Communication Space, supplies services supporting a distributed system and network services.

II.2 Layer of a Set of Reusable SITB

This layer is represented by a set of functional, independent, and reusable components. These components will be shared and reused for creating a new service. We have identified with a participation of educationalists two kinds of resources: didactic (teaching activities) and information resources ("bricks of domain")[Canut 94], [Vincent 94].

From reusing of these types of resources a training service can be specified as a dynamic training service. The criteria of reusing of didactic and information resources are determined by learner's educational needs. The dynamic training service must diagnose an adequate resource that responds to learner's educational needs. In this way a dynamic training service is considered as an adaptable service.

II.3 Cooperative Service Layer

This abstraction level represents the two kind of cooperative training services provided by this architecture. We consider two kind of adaptable services [Hernández 95c]:

a) global level represents a virtual class composed of a set of remote learner groups and
b) local level represents a particular learner group, each remote learner group is classified by a knowledge level.

These two classes of cooperative services must be adaptables to learner's behavior in a training session.

The composition criterion of virtual class takes into account a pedagogical context, this pedagogical context is based on the cooperative learning [Doyon 91]. A virtual class will be composed of a set of heterogeneous groups, each group allows to a set of remote learners to participate to a training session. In a traditional class the homogeneity of knowledge level is not always assured. Some cases, this homogeneity of knowledge level becomes very superficial. For solving this problem, we consider a first level of adaptation to learner's educational needs, this first level correspond to take into account a composition of a virtual class from heterogeneous groups. These groups have a variable composition [Hernández 95d]. Each heterogeneous group corresponds to a different level of knowledge allowing to characterize a group of learners with the same level of knowledge about a particular domain. However, inside a group of learners is possible to find different behaviors of learners according to progression rhythm of each learner. The second level of adaptation is taken into account into a group of learners. A particular knowledge level associated to a group of learners may also become superficial and not adapted. For preventing this problem, we propose to consider the behavior zones into a group of learners. In this case, it is necessary to allow and manage the change of behavior zone of a learner inside a group (*inter-group change*) for assuring an adapted knowledge level of learners inside a particular group (local view). For assuring an adapted virtual class (global view) is also necessary to allow and manage the change of group (*intra-group change*).

II.3.1 The Adapted Training Service of a Virtual Class

The adapted training service of a virtual class has as principal functionalities:

a) the managing of progression of a set of remote learners,
b) the controller of the VCTS (Virtual Class Training Service) takes into account a pedagogical, structural and adaptable control of a virtual class.

An initial composition allows to create a set of heterogeneous groups, this initial composition is based on a learner evaluation. However, for preventing that the initial distribution becomes static and not adapted during a training session, we must consider a *logical mobility of learners*. This logical mobility must respond to learner's educational needs according to behaviors detected of a group of learners during a training session. So, two levels of distribution of learners have been considered: *variable groups* corresponding to level of class and inside a group of learners, that is a set of *behavior zones* have been established (figure 3) [Hernández 95c].

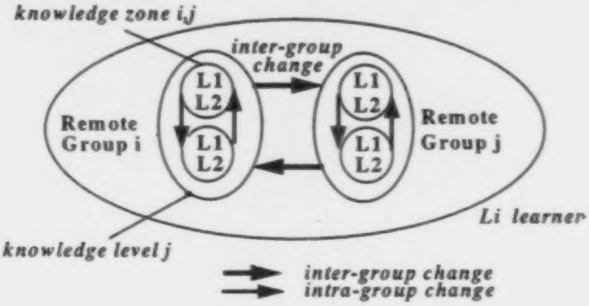


Figure 3: The distribution of learners in the virtual class.

II.3.2 Group Training Service

A controller of a Group Training Service (GTS) must adapt a training session to learner's educational needs.
The actors considered in a virtual class are: remote learners, teacher and shared didactic resources (didactic and domain entities).
A didactic interaction is a teaching interaction of cooperative type based on the roles played by actors. A role may be played by several actors [Depaoli 91].
A local didactic strategy is represented by activating didactic interaction. These didactic interactions are managed by the controller of a GTS.
The controller of an GTS must establish a dialogue with the controller of the virtual class. This dialogue allows to indicate either a learner may change of group or a learner has a problem or a learner send a request (when he wants to express a problem or point of view).
We established with educationalist team three behavior zones inside a group, these behavior zones represent three types of possible progressions: normal, intermediate and critical zones [Hernández 95c]. The control of these behavior zones represent a *fine adaptation to knowledge level* and to learner's educational needs.
The architecture for each controller of a group training service (GTS) was specified in [Hernández 95d].

III Specification of the VCTS

The VCTS must assure the knowledge transmission of a domain to teach. The VCTS has to manage a training session of a virtual class which is composed of a set of remote learner groups. It must also supervise and adapt the execution of a pedagogical strategy in a flexible way.

III.1 Architecture of Controller of the VCTS

The controller of the VCTS is composed of the following modules [Hernández 95d] (figure 4):

a) managing module of communication (event manager) with each controller of a GTS. This module must analyze each event sent by a controller of a GTS.

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b) pedagogical module must manage a pedagogical strategy. The principal objectives of this module are: managing of pedagogical goals (knowledge transmission and knowledge evaluating), supervising of homogeneity of knowledge level associated to each group, and providing pedagogical aiding. This pedagogical aidings may be provided by different ways: using a didactic resource which is represented by a computer intervention, a teacher intervention is necessary for having similar functions as a traditional class (explanations, resolving doubts, providing advises, ...), and in the context of cooperative learning a learner intervention is also necessary.

c) behavior managing module of a group of learners. The VCTS has a *global view* of a virtual class composed of a *set of groups*. The global view is represented by a *set of group profiles*. Each GTS has a *local view* which is represented by a *set of learner profiles*.

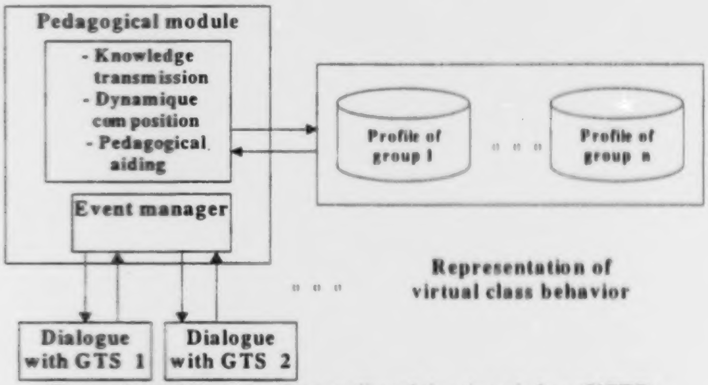

Figure 4: Architecture of controller of the virtual class (VCTS).

Now, we are going to develop the architecture of the VCTS.

III.2 Managing Module of Communication

This module is represented as a module that manages all interaction with each controller of a GTS. These interactions between controllers are represented by events. An event is considered as *a client-server interaction* between controllers. The controller of VCTS must manage each event sent by a controller of GTS. The event is analyzed and an interaction must be established. The controller of VCTS gives a response by an event. This event may be an *pedagogical goal*, a *change of group*, and *get in contact with a teacher or another learner*.
All dialogue event between controllers is represented by a pedagogical control interaction according to an object-oriented approach [Hernández 95c]. The execution of an interaction correspond to execute a communication protocol [Hernández 95d].

III.3 Pedagogical Module

The ICAL system must adapt a pedagogical method according to learner's educational needs [Canut 90].

Training session

A course is represented by a set of training sessions which are composed of general pedagogical objectives. A progression class is managed step by step: a general pedagogical objective is represented by a set of intermediate pedagogical objectives. Each intermediate pedagogical objective is associated to control interactions ("speak", "inform","tutor", and "ask-answer").

ADAS process

The VCTS controller works according to *Action-Decision-Analyze-Supervision (ADAS) process*, this process is also used for specifying the didactic module of a GTS controller. The general way of ADAS process is represented by the following representation.

Supervision *------- When an event is detected*
Analyze *------------------ Analyze type and context of an event*
Decision *---------------------- Diagnose roles and actors*
Action *------------------------------Establish to pedagogical control interaction and*
Execution of pedagogical control interaction

An event receipt may be: a status of a pedagogical objective (*status-pedagogical-objective*), an important regression (*regression*) or an important progression (*progression*) of a learner.

Pedagogical objective

The transmission of a pedagogical objective is represented by a pedagogical control interaction (figure 5).

Type of interaction: "pedagogical objective"
Parameters: "next pedagogical objective"
Type of relation: "1..1"
Context of interaction
Scope: string
Actor_initiator: "id_GTS"
Role_i: "client"
Actor_answer: "controller of VCTS"
Role_a: "server"

Figure 5: Representation of the pedagogical control interaction: next pedagogical objective.

```
When status-pedagogical-objective is OK
        next pedagogical objective = pedagogical strategy
                                        (current pedagogical objective)
        instantiation of next pedagogical control interaction
        execution of next pedagogical control interaction
```

Dynamic composition and pedagogical aiding are also represented and analyzed as a pedagogical objective, that is, a pedagogical control interaction and a ADAS process are also established and executed [Hernández 95d].

IV An Implementation of an Adapted Virtual Class

An example of a virtual class in the context of SEMIEC (In french: Service Evolutif Multimédia de Enseignement de la Comptabilité) has been developed at IPST (French institute for professional training) [Hernández 93b]. The tool of development was the product RPC (Remote Procedure Calling developed by Sun Microsystems) [Bloomer 92] allows to develop distributed systems. The architecture used is based on reusing of reusable SITBs. The pedagogical control is distributed between: the controller of virtual class (VCTS), the manager of SITB server, and the controller of group of learners (GTS).
Several RPC servers have been developed allowing to manage the events (figure 6). We have specified a server associated to each learner, a server is associated to the teacher, a server is also associated to controller of VCTS for managing the communication with a controller of an GTS, and a server of reusable SITB is implemented to manage the reusing interactions.
This architecture allows a distributed processing of pedagogical control. The programming of this application has been realized using of the language C for managing the communication channels and the language C++ for implementing the cooperative interactions according to an object-oriented approach.

V Conclusion

The architecture of the virtual class proposed is a response to traditional virtual classes which are not adapted. The virtual class proposed takes into account different types of learner progressions (behaviors). The virtual class considered is adapted allowing and controlling the learner mobility. This logical mobility may be inside a learner group (intra-group or change of zone) and outside a learner group (inter-group or change of group). This system provides a teaching function distributed between different actors: learners, teacher and resources. This teaching function allows: to use of cooperative learning, to give remote pedagogical aidings, and to apply remote tutor functions.

Works are in progress for implementing a server of reusable SITB in the object-oriented programming methodology domain. This server will be implemented using of Internet, the access to server will be analogous to a learning environment. The same server will be also used for reusing a set of reusable SITBs and adapting them in a virtual class by Internet.

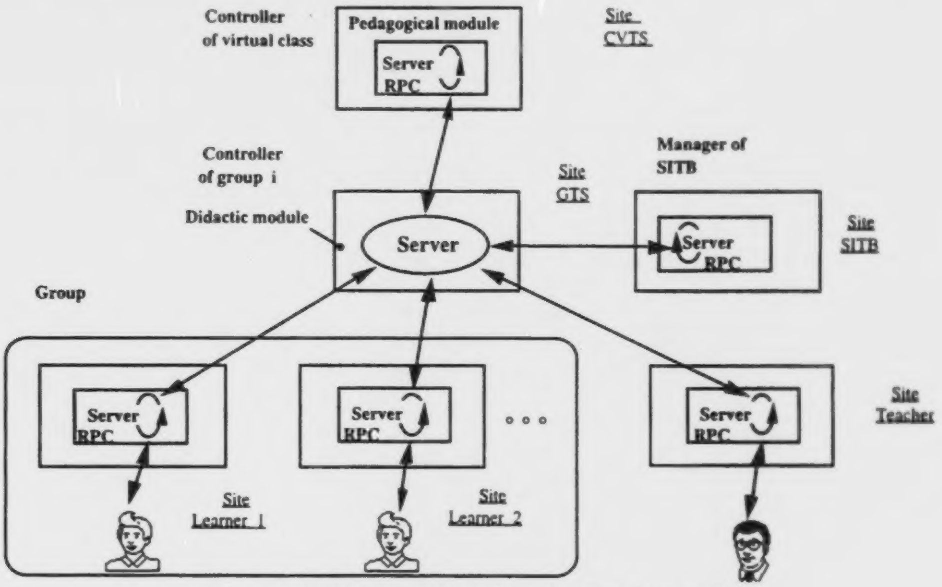

Figure 6: Architecture of an adapted virtual class on RPC.

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Avenues to Understanding: A Qualitative Study into How Students Learn From Multimedia

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Abstract

Many interactive multimedia programs direct learners down a one-way street. This paper describes a program based on a situated learning model which sought to open up the 'avenues to understanding'. Nine critical characteristics were defined from the extensive literature on the situated learning and used to inform the instructional design of a program on assessment strategies in mathematics. The paper describes a preliminary evaluation of the situated learning framework by investigating the use of the multimedia program by two students, and their thoughts opinions and feelings about learning from this type of program. Early findings indicate that it is a successful approach enabling students to construct their knowledge about the topic in an effective, non-linear, and collaborative manner.

Introduction

There has been much use of the travel metaphor in the educational technology community in recent times. There is talk of the superhighway, the fast lane, traffic congestion, and express delivery. And yet much of the interactive multimedia available today is more akin to a single, one-way street than a superhighway. In the one-way lane, there are few options once you begin. There are no feeder roads, no exits, no turns, no signposts, no choices. The student using such a program is a captive audience who must proceed from beginning to end, responding in a manner deemed appropriate by the designers, interacting with the program in foreseen ways, and exiting at the end without contributing to the lonely, sober journey.

This paper describes a program which was designed to put the student back in the driver's seat with a map, a destination and co-drivers. It enables learners to leave the one-way lane and investigate whichever avenues or highways they choose. The program began with a different theoretical framework. The prevailing model for the design of multimedia programs at the time of commencement was comprised of several steps, typically: a question or problem of some sort is displayed; the student is required to respond actively, for example, by selecting an answer; feedback is given, such as praise for a correct answer or correction of an error; errors are minimised by presenting material in small steps or by using techniques such as prompting and chaining; and students are free to work at their own pace. This model has been used to guide much of the multimedia developed to date. It is the format used by Skinner in the 1950s for the programmed instruction used with early teaching machines (Farnham-Diggory, 1992), but is still recognisable in many contemporary multimedia programs. It is understandable that Brown (1994) has asked for recent learning theory to be used in preference to 'outmoded theories of learning that are relics of psychology's behaviouristic past'(p. 11). Other authors and developers, such as Park and Hannafin (1993), and Lebow (1993) believe that little more than technological capacity and the intuition of designers are driving the design of multimedia, rather than research and theory.

The theoretical framework used to guide the development of this program was that of situated learning (Brown, Collins, & Duguid, 1989; Collins, Brown, & Newman, 1989; Lave & Wenger, 1991; McLellan, 1993; Young, 1993). Nine critical characteristics were defined from the extensive literature on the subject and used to inform the instructional design of the program. The learning environment needed to:

- provide an authentic context that reflects the way the knowledge will be used in real-life;

- provide authentic activities;
- provide access to expert performances and the modelling of processes;
- provide multiple roles and perspectives;
- support collaborative construction of knowledge;
- provide coaching and scaffolding at critical times;
- promote reflection to enable abstractions to be formed;
- promote articulation to enable tacit knowledge to be made explicit; and
- provide for integrated assessment of learning. (Herrington & Oliver, 1995, p. 255).

A program was developed to enable teachers and pre-service teachers of mathematics to explore issues of assessment, entitled *Investigating Assessment Strategies in Mathematics Classrooms* (Herrington, Sparrow, Herrington & Oliver, 1996). Twenty three assessment strategies suitable for use in K-12 classrooms were identified and presented in a multimedia format. Five complex, authentic activities were designed consisting of memos and other documents, to enable students to explore the resource within the parameters and constraints of a realistic task. The interface simulates the front part of a classroom with the resources located in full view (see Figure 1). The student accesses each resource by clicking on the appropriate part of the picture.

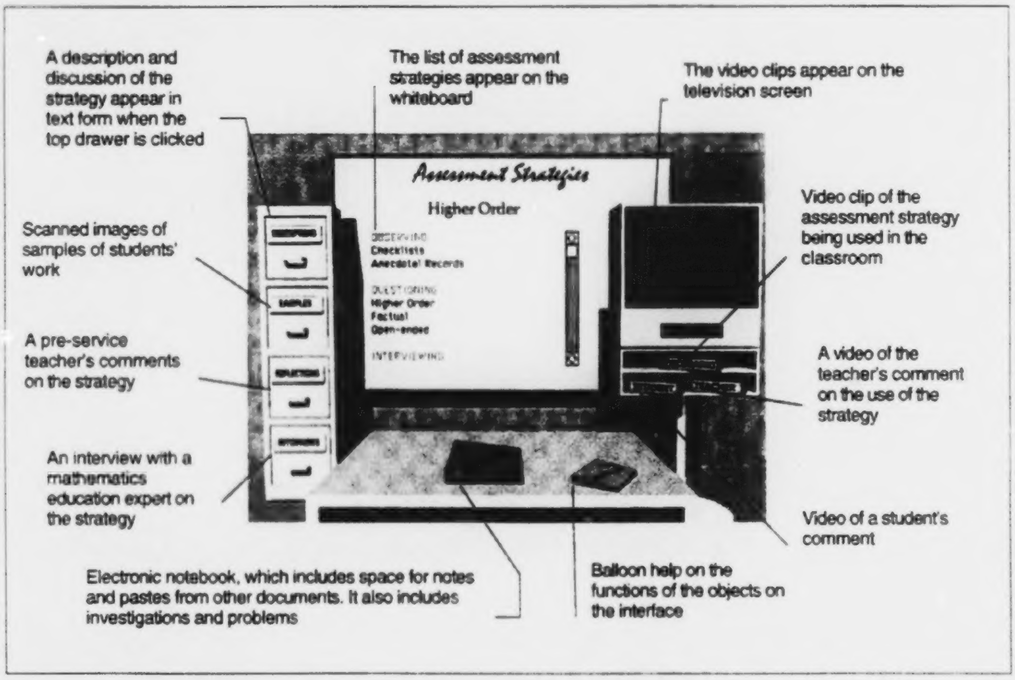
A description and discussion of the strategy appear in text form when the top drawer is clicked
The list of assessment strategies appear on the whiteboard
The video clips appear on the television screen
Assessment Strategies
Higher Order
OBSERVING
Checklists
Anecdotal Records
QUESTIONING
Higher Order
Factual
Open-ended
INTERVIEWING
Scanned images of samples of students' work
Video clip of the assessment strategy being used in the classroom
A pre-service teacher's comments on the strategy
A video of the teacher's comment on the use of the strategy
An interview with a mathematics education expert on the strategy
Video of a student's comment
Electronic notebook, which includes space for notes and pastes from other documents. It also includes investigations and problems
Balloon help on the functions of the objects on the interface

Figure 1: Main interface of the assessment strategies program

A study was designed to observe students' use of the interactive multimedia program and to investigate the effect of the situated learning framework on how students learn. Two preservice teachers were videotaped as they used the program and presented a report, over a period of three weeks' class time (9 hours). At the end of the period, each student was interviewed. Data was transcribed and analysed with the assistance of NUD•IST, a computer-based qualitative analysis program.

Authentic context

The authentic context presented to students was one of a physical and conceptual structure of a classroom which users were free to explore. The various media elements available to the user of the program provided authentic

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data from a variety of perspectives. Students had access to more than 60 video clips, over 60 text files and over 20 graphic images and documents, as well as a notebook facility to record their own notes. A sufficiently rich and complex knowledge base was necessary to enable students to solve realistic and complex problems. Generally however, students did not recognise that they were working in a complex learning environment. This is consistent with Honebein, Duffy and Fishman's (1993) premise that it is not necessary to simplify learning environments to enhance learning, and that providing 'realistic levels of complexity' in a learning environment can help to make learning easier (p. 95). While the interface and navigational paths of the program were deliberately kept as simple as possible, the conceptual nature of the contents was far from simple. This was acknowledged by one student:

> I was actually surprised at how much you can learn from such a simple brief program. There was just so much in there that you could learn from. (Interview with Deborah)

The predominant feature of the context of the assessment program was that students appreciated the real-life relevance of the material they were using. They frequently pointed out the contrast between the authentic context presented in the program and the decontextualised approach:

> It wasn't like academics discussing the relative theories and things like that, which is what we get lot of at uni. It was actually teachers showing how they'd implemented it, and discussing it afterwards. (Interview with Glen)

Authentic activities

The activity was designed to incorporate all the uncertainty and unpredictability of an authentic task. Students were provided with a copy of a letter of complaint from a parent, together with a memo from the Principal requesting a plan of action to remedy the problem. The task was ill-defined. There was no summarising question or topic for the investigation, simply the presentation of the two documents. Students' first task was to work out exactly what they were required to do. Collins (1988) has pointed out that students often invoke 'suboptimal schemes' for remembering information and to help them cope with the day-to-day demands of school learning. For example, arithmetic students might conclude that any word problems including the word 'left' (How many did she have left?) are subtraction problems. One student revealed the 'suboptimal scheme' she used for 'finding the question':

> We had to read it four or five times to actually get out what it was asking us to do... because the actual question was in the middle, it wasn't at the bottom and it wasn't at the top, we sort of had to look through and go 'Oh there it is'. (Interview with Deborah)

This comment reveals that the student's standard procedure of looking at the beginning or end of an activity for the 'actual question' did not work in this case. The students spent considerable time not only identifying the requirements of the task, but also in breaking that global task into sub-tasks. There was active engagement in finding and defining these composite problems as well as solving them.

Expert performances

The assessment strategies program gave students access to expert performances in three ways. Firstly, the video clips of the scenarios being demonstrated in the classroom were generally performed by experienced teachers who were well acquainted with the use of the strategy. Secondly, students had access to the commentaries provided by 'experts' in the field of mathematics education and assessment strategies in the *Interviews* drawer of the filing cabinet. Thirdly, students were able to read the reflections and advice provided by third year student-teachers who were only one year more experienced than the students using the program. While students were generally very positive about the exemplary teaching provided in the scenario videos, none commented on the 'window into practice' or the social or cultural insights into classroom life that the video scenes might have afforded. They were very much focussed on the videos as demonstrations of the assessment technique in a real life context.

Multiple perspectives

The assessment program enabled students to access multiple perspectives in two distinctly different ways: one related to the way the assessment strategies were presented in the program, and the other to the task that students

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were given to complete. The program presented a variety of perspectives on each assessment strategy, from the teacher's, student's, pre-service teacher's and expert's point of view. One student, comparing the program to a traditional lecture, indicated that the multiple perspectives provided many 'avenues to understanding':

> In a lecture you can't click onto the video and get the video to play. When you've got a huge lecture situation, the lecturers can't keep stopping and going ... Whereas with this it gives you so many avenues to understand it from. You may not understand the theory side but you can understand the scenario side and then find out what the teacher thought. There's just so many different ways of looking at that one strategy. (Interview with Deborah)

The task students were set as an investigation also required them to present a report which included implications for three different groups. Prompted by a complaint from a parent, the 'new teachers' at the school were asked to prepare a suggested plan for assessment in mathematics 'including benefits and problems for parents, students, and teachers'. The group did not complete the different perspectives required in this task beyond recommending a suggested assessment plan for the school. Nevertheless, there was much evidence to suggest that students viewed the material several times, in different ways, and used 'alternative routes of traversal ... criss crossing a topic in many directions' (Spiro, Vispoel, Schmitz, Samarapungavan, & Boeger, 1987, p. 188). Regardless of which pattern of use was adopted, students rarely used a linear or regularly systematic approach in searching the media elements. Both students spoke of looking at items more than once if necessary, going back over items, and investigating individual elements in greater depth.

Collaboration

While using the interactive multimedia program on assessment, students worked in small collaborative groups of 2-3 students grouped around each computer. Students perceived many clear advantages in working collaboratively. One advantage is that the completion of the task benefited from collaboration with another person, essentially that view that 'two heads are better than one'. A frequently mentioned advantage of working collaboratively was that the partner often helps by telling or explaining something that the student didn't know or understand. The view was also expressed that, at times, collaboration is essential to continuation of the task. In the absence of a partner, this support would be provided either by the teacher, or as one student pointed out, by 'annoying' the person on the next computer:

> The fact that if you're confused about something you can ask somebody and they're right there next to you. You don't have to put your hand up and wait till the teacher gets to you. And you're not ... trying to annoy the person that's on the next computer, ... you've got someone to ask. (Interview with Deborah)

This view sees collaboration as essential to learning, that it is sometimes obtained by stealth, and that it is given necessary legitimacy by the arrangement of students into small groups.

Reflection

In order to provide a learning environment which would promote reflection, the assessment program was designed primarily with an authentic context and an authentic activity to enable students to engage with the program and to reflect upon it in a meaningful manner. It was also designed to enable multiple entry points, non-linear navigation, and access to an electronic notebook to enable students to note their reflections and ideas immediately. Neither of the students overtly attributed the non-linear navigational aspects of the program as an aid to reflection, although this did appear to be a contributing factor to reflection. The findings suggest that the learning environment did allow students to freely reflect on their learning by providing them with a multimedia program and collaborative working arrangement which enabled them to return to experiences, attend to feelings and to re-evaluate the experience (Boud, Keogh & Walker, 1985). The students were able to share their reflections with each other and use the notebook facility to conveniently record them, confirming Ennis's (1985) belief that reflection is a social process.

Articulation

Students articulated their understanding of assessment strategies in two ways: the formal report to the staff meeting, and in their discussion with their partner as they used the program. Many interactive multimedia programs do not allow either form of articulation to occur. Students are assigned individually to computers to

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work alone, and in so doing, the knowledge remains tacit. Lave and Wenger (1991) point out that being able to speak the vocabulary and tell the stories of a culture of practice is fundamental to learning. The students were aware of the difference between tacit knowledge and verbalised knowledge. One student pointed out the difference between 'knowing' and verbalising in a manner which suggests that the knowledge is incomplete unless it can be articulated, and that knowing 'in my mind' is little more than a good starting point for further research. The students were also clearly aware of the importance of articulation to learning. However, they almost invariably viewed articulation as an act of clarifying an issue rather than an integral part of the learning process itself. Counsellors and psychologists have long been aware of the importance of verbalisation in beginning to affect change in problematic behaviours. A frequently quoted psychological law of counselling is 'I learn what I believe as I hear myself speak' (Saunders & Herrington, 1995, p. 8). Similarly, Baktin (1986) contends that 'any true understanding is dialogic in nature' (cited in Brown & Campione, 1994, p. 267). The implication is that the very process of articulating enables development, refinement and awareness of thoughts:

> If you have to put something into words, you have to think. (Interview with Glen)

Students using the assessment package were also very much aware of the value of formally articulating their learning in presentation of reports to their classmates, or as Pea (1991) describes it 'creating rich conversational artefacts for discussion and presentation' (p. 65). Students were surprisingly positive and comfortable with the prospect of presenting a report to a larger group (given that fear of public speaking is often ranked more highly than fear of death in popular surveys) and in this sense, they may not have been typical. However, one student pointed out that reports to class were more and more becoming a standard feature of their university classes.

Coaching and scaffolding

From the analysis of the data, it is apparent that coaching and scaffolding is provided essentially from two sources: the teacher, and the student's partner in the collaborative groups. The teacher of the class being observed was thoroughly familiar with the program and its possibilities, and knew the requirements of the coaching and scaffolding role. The role of the teacher was seen as one which essentially clarified issues for students and was important because it saved time. It enabled the students in the study to proceed with the knowledge that their effort was 'on the right track' and that the support given to them was precisely at the point they needed it. The assistance provided by the teacher was essentially procedural on both content (e.g., Is it meant to be a written report?) and software (e.g., There's no sound on this video). In the lessons observed, students rarely consulted the teacher on higher-order questions related to the task. However, the arrangement of students into collaborative groups meant that the student's partner could provide a coaching and scaffolding role. This support was particularly evident in the higher order thinking related to the investigation the students were doing. The students were aware of the influence interactions with their partner had on the depth of their learning. For example, when asked to describe the advantages of working in pairs, Glen showed considerable understanding of the concept of scaffolding and how it relates to his own learning:

> If you've got somebody else ... you scaffold a bit. Like when you go 'Oh cool, this is what it means' and the other person, who might not have even considered it goes 'Oh yes' and then takes it a step further and you end up doing more indepth thinking about it. Otherwise I might just have a bit of a superficial look at it. (Interview with Glen)

Students were very positive about the supportive role their partner played, and clearly linked the arrangement of students into collaborative groups to the value of articulating their own growing understanding of the issues.

Integrated assessment

The assessment program included an activity which required students to propose new assessment strategies for the mathematics department in a school. It was this one activity which they investigated for the entire three week period, and it was this activity upon which they were assessed. Students were required to give both an oral and a written report of their proposal. When questioned about the value of a type of assessment which is closely tied to the use of the program, the two students were very positive about it. Both felt that such a close connection between activity and assessment meant that it was virtually impossible to 'regurgitate' information in a meaningless manner. Similarly, with the written report, they felt that an essay, had it been set, would have allowed a lot more 'drivel' as opposed to the tighter requirements of an authentic report.

Conclusion

This paper has described a preliminary evaluation of a theoretical framework for the design of interactive multimedia based on a situated learning model. In so doing, it has investigated the use of a multimedia program by two students, and their thoughts opinions and feelings about learning from this type of program. Early findings indicate that it is a successful approach enabling students to construct their knowledge about the topic in an effective, non-linear, and collaborative manner. This preliminary study is currently being followed by a more extensive evaluation of six students' use of the program, including an investigation into their practical use of assessment strategies in teaching practice in schools. It is hoped that the current and more extensive study will suggest many seeds for further research, both analytic and systemic (as described by Salomon, 1991), into the manner in which students learn from interactive multimedia.

It is proposed that roadblocks have been set up by interactive multimedia programs which seek to deny students any choice in how they progress, which try to control the nature of the interaction between the computer and the student, and which limit collaborative opportunities by insisting upon a single user at each computer. The multimedia program described here is an attempt to open up those avenues of understanding.

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Metaphor Vocabularies: An Evolution of the 'Electronic Book' Metaphor to Support the Collaborative, User-Centred Development of Integrated Computer Based Instruction.

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Abstract:
The use of CBI software to support the educational requirements of healthcare professionals, patients and students has been a continual source of research and application. However, little attention has been focused on the development issues central to CBI which support the needs of today's patients, who are beginning to play a more integrated role in their own health care. Such software must not only help to attain the educational objectives and requirements of the patient, but should facilitate the support of healthcare issues, trends and objectives of the environment in which it resides. In its development, we must not only address methods of instruction, educationally competent and functionally correct user-interface designs, but must identify, develop, utilise and annotate clinical relational data that flows across system management boundaries. To achieve the characteristics of educational integration and support the increasingly active and participatory role of the patient in clinical decision making, preferences and expected outcomes, computer-based patient education must be seen as *a technological support for clinical effectiveness*. The challenge of development must embrace important facilitators which aid the conceptualisation and evolution of this specialised CBI software. In this paper, we present a synthesis of opinion from various research arenas such as cognitive engineering, educational technology and medical informatics, with specific attention focused upon the evolution of the electronic book metaphor to support the user-centred, collaborative design of educationally integrated, computer-based patient education.

Introduction

As part of a PhD research collaboration between the Computer Science Department of the University of Wales, Cardiff, and Velindre Hospital (a specialist cancer treatment centre in Cardiff), we are developing a networked educational environment which can encapsulate and manage numerous multimedia computer-based patient education applications, integrated into Velindre Hospital's information-rich healthcare setting. The evolution of such an environment and the development of these specialised applications, present unique challenges. We have produced specialised *patient-knowledge management* software to develop and manage healthcare multimedia 'electronic books' which serve to support the increasingly participatory role of the patient in their own health care. At the heart of the development of these CBI applications and the evolution of the educational environment is a user-centred and collaborative development philosophy supported by a concept we term a 'metaphor vocabulary'. This is an evolution of the 'electronic book' metaphor which has become a much discussed development concept and design paradigm in the educational computing community. We believe the use of this vocabulary is an essential aid for user-centred, collaborative development of complex yet usable clinical CBI. Whilst a detailed commentary on our patient-knowledge management and development software is beyond the scope of this paper, we take the opportunity to discuss the importance of the 'electronic book' metaphor and its recent use. We then comment upon a suggested evolution into a metaphor vocabulary to support the development of more integrated, educational software for patients.

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Summary of the Electronic Book Metaphor, Past and Present

Theory and Application

The electronic book metaphor is not altogether new. Philip Barker, in his book 'Author Languages for CAL' [Barker 1987] discusses two authoring software systems which utilised the book paradigm for educational software development and use. These date back to the early eighties. Otsuki and Takeuchi's 'BOOK' system of 1981, developed in Japan, was used to develop CBI applications which outwardly resembled books in that they included titles, content lists and indexes. These books could be grouped together into a library which allowed them to be accessed by author or title. ComCAL, developed by Donaghy in 1985, also used the electronic book metaphor and was written in Pascal. These books were organised into chapters and pages.

The traditional 'electronic book' metaphor allows the end-user and developer to conceptualise a CBI application as a computerised version of a traditional 'paper book' with additional characteristics such as hypermedia functionality, assessment and feedback. Until recently, graphical user interfaces were not capable of replicating a visual book on screen. With improved authoring tools, processing power, visual high resolution and graphics packages, it is now possible to build interfaces with a two dimensional book design as a backdrop to educational content. These applications can further mimic the paper book by providing a contents page at the start of the application and an index at the end [Benest 1991].

The proliferation of commercial educational software and authoring software which utilise the electronic book metaphor appears to amply justify the viability of an electronic book development paradigm. Successful 'off the shelf' education titles include multimedia encyclopaedias, complete literary works, classical music and composers, geography atlases, GCSE and A-Level revision books. The most successful beneficiaries of the book metaphor include interactive language titles which exploit the idea of the electronic book to the full [Barker 1994b].

Metaphors, Myths and Models

Barker and Manji [Barker 1991] describe the cognitive aspects and relevance of the electronic book metaphor. They see the metaphor as an aid to the formation of sets of conceptual models that learners apply to different learning situations. Conceptual models form part of the cognitive make-up of the computer user, providing the means by which a user understands and uses various computer systems. Barker and Manji go further in their discussion of metaphors by introducing the concept of the 'myth'. The 'myth' is a metaphor used at the interface level of a system to aid the conceptual model of the system to which the interface relates. The 'myth' enables the designer to actuate and orientate a user's cognitive activity. Where a metaphor does not exist at this level, they suggest that one may be designed according the user's cognitive framework of the real world. The authors imply a hierarchy comprising pages at the base level, chapters at the intermediate level and a single parent book at the summit. The 'page' contains the educational media.

Doubtless, few commentators could not have foreseen the rapid evolution of visual development applications of this decade, which make use of metaphors at both the development and user interface. Like many 4th generation visual development tools, ToolBook uses a specific metaphor-supported conceptual model; in this instance to present the developer and end-user with individual pages, each one relating to a single multimedia screen or frame which together constitute the 'application book'. Control code, modules and procedures can be placed in a 'control book' which is a parent to the application book being developed. Microsoft's Visual FoxPro utilises a 'forms' metaphor as an aid to the development of highly graphical interfaces to relational data tables. It would appear that the concepts of a 'myth' and the metaphor have been realised in commercial development software, implying that metaphors are relevant to end-users and developers alike.

The Electronic Book Metaphor and Integrated Clinical CBI

Medical Informatics and Educational Computing: Metaphors are Equally Applicable

'Metaphors communicate real-world analogies, and communication is at the core of what defines usability (*sic.* of clinical information systems). A 'mind map' facilitates communication by building a model in the user's mind' [Esterhay 1994].

'A metaphor is primarily a likeness or analogy to a concept that already exists within a cognitive framework' [Barker 1991].

Both of these informal definitions apply to the use of metaphors in the development of software. However, Esterhay's comments refer to medical informatics - specifically the development of clinical workstations, and Barker's comments refer to educational computing - specifically the development of CBI applications under the development paradigm of electronic books. The enthusiasm for the book paradigm (which includes study books, text books, encyclopaedias, guide books and others) is such that the authoring and evaluation of electronic books have been treated by educationalists specialising in educational software as a separate CBI development issue [Barker 1994a, Richards 1991, Collis 1991]. With some exceptions [Santer 1994, Mooney 1995, D'Alessandro 1993, D'Alessandro 1995], the benefits of the electronic book metaphor have so far received little attention in the field of medical computer based instruction.

As we will discuss, we believe this metaphor is as applicable to computer-based patient education in clinical environments as it is to computer based education for schools, colleges and commerce.

The Need for Metaphor-Supported, User-Centred CBI Development

Even before today's authoring software tools provided database connectivity to table based relational databases such as dBase and FoxPro, and true relational databases such as Ingres and Oracle, emphasis was growing on the use of more complex networked and distributed educational software systems. De Diana envisages the use of networked electronic books sharing resource and other networked facilities such as electronic mail [De Diana 1991]. Much recent attention has been focused on the World Wide Web for the availability of distributed educational resources [D'Alessandro 1996]. The Internet is not viewed as being an appropriate network medium for all forms of computer based education at Velindre Hospital. We are primarily interested in integrating computer based education into the information structure of the hospital which includes confidential patient data held in our own clinical information system. Owing to the confidential nature of patient information and the consent required for its use, the Intranet is also viewed unfavourably. We envisage our *educationally integrated* computer-based patient education, as characterised by the inclusion of patient data, protocols, treatment options, philosophy, organisation and clinical opinion, and support for healthcare issues and trends such as patient-centred decision support, informed patient consent to treatment and the production of tailored patient information. Internally produced CBI applications sharing confidential networked patient data with our patient information system, sharing educational resources and helping to meet external healthcare objectives, require a development process and conceptualisation of the end product which is fundamentally more involved and complex than traditional CBI applications that focus purely on educational objectives.

Suitable collaborative development philosophies, supportive conceptual models and development metaphors are of paramount consideration if the potential for computer-based patient education is to be exploited, applied and utilised.

Supporting the User-Centred, Collaborative Development of Clinical CBI

The extension of the electronic book metaphor to increase functionality and features has been well documented by Mayer and Mulder with their NEAT project [Mayer 1994] . Reference can also be made to the Calsa project of Barker and Giller [Barker 1994b]. Metaphor extensions not only encompass new features and functionality for CBI development. We argue that if the electronic book metaphor can be adequately extended to include a vocabulary of related metaphors which can accommodate both development and end-use of CBI software [fig. 1], it is possible to support collaborative and user-centred development. The result of a vocabulary of related metaphors is a 'metaphor dialogue' between those who are party to the collaborative development effort. In specialised, clinical environments comprising conglomerate, specialised units or 'firms', and varying levels of computing expertise amongst individuals, a metaphor dialogue can be an invaluable asset for promoting effective discussions across boundaries of working culture and computing experience. This facilitates: consortial development communication, an increase in the usability of the end product and a reduction in the risks typically associated with health care software development.

Metaphor	Development Equivalent	Product Equivalent
Medical electronic book.	CBI application.	CBI application.
Chapter.	Individual authoring workspace. Application module.	Educational subject module.
Topic.	Sub division of an individual authoring workspace. Application sub module. Grouped Multimedia Frames.	Sub division of an education subject module.
Page.	Multimedia Frame.	Educational screen. User Interface.
Library.	Data Base.	External information.
Personal Reference Library.	Patient data and Learner data.	Supplementary on screen information and Interrogative data requirements.
Educational Reference Library.	Educational resource.	Educational content.
Library index.	Data entity.	-
Library index subheading.	Data attribute.	-
Index cross references.	Entity relationships.	-

Figure 1: Extract from the Metaphor Vocabulary

The possibility of a development relationship existing between a metaphor vocabulary and collaborative, user-centred development is explored below.

The use of a user-centred approach to system design and engineering, and the resultant impact on human computer interaction has been well documented by a number of authors. Donald Norman comments that "..user centred design emphasises that the purpose of the system is to serve the user, not to use a specific technology, not to be an eloquent piece of programming. The needs of the user should dominate the design of the interface and the needs of the interface should dominate the design of the rest of the system.." [Norman 1986]. The requirement for a collaborative, user-centred design approach becomes more dominant as task complexity, conceptual image complexity and problems of user-understanding become noticeably more difficult to address. In support of user-centred design, Norman also discusses the use of conceptual models and a system image in response to the problems associated with the differences between the human and system facades of the user interface. Two mental models and one physical model are suggested by Norman such that the design of a system follows a consistent, coherent conceptualisation (a design model), and enables the user to develop a mental model of the system (a user model) consistent with the design model. To facilitate these models, the developer needs to construct an appropriate system image of the physical structure of the system. It is interaction with the system image that promotes compatibility between user model and design model. Norman also states that this places a severe burden on the designer, particularly as the system image needs to be explicit, intelligible and consistent.

Where user-centred design embraces a collaborative development philosophy, we believe the need for compatibility between Norman's various conceptual models is of primary concern since the end-user or product commissioner is active in all of three conceptual domains. Using our metaphor vocabulary and a highly visual development software, we have succeeded in producing an enveloping conceptual model called the 'conceptual development paradigm' which effectively maps the user model, design model and system image into a single conceptual framework.

As an example, the physical system relationship between CBI software and networked clinical data at Velindre Hospital can be viewed in terms of the open database connectivity which facilitates the use and annotation of data held in a clinical information system. The conceptual development paradigm uses the metaphor vocabulary to map this to a design model comprising access to external libraries of patient data which can be utilised by investigating the indexes (data entities) and their subheadings (data attributes) which catalogue the library resource structure. The user model comprises a conceptual view of the interface as a page of the electronic book which is not only decorated visually, but is also automatically re-edited when the reader 'turns a page' to incorporate up to date clinical data from external libraries of patient information.

The emphasis we place upon the importance of collaborative development is reflected by a number of authors from various research communities. The relevance of collaborative authoring of educational software has been considered in detail by Min and Rada in the context of computer supported co-operative work (CSCW) and the Dexter Groupware model for collaborative authoring and document re-use [Min 1994]. Collaborative authoring is seen as particularly relevant to the authoring of complex distributed educational software systems.

Nielson and Thomas comment on the merits of using a consortia model of software development to foster a collaborative approach as educational software becomes more complex in its design, distribution and use, and attention focuses towards networked educational resources [Nielson 1996]. Our metaphor vocabulary embraces the use of external clinical and educational resource, with sufficient vocabulary content to support collaborative discussions to this effect. In addition, we have been able to target expertise by using the metaphor vocabulary to support the definition of basic data structures before requiring system developers to build the necessary data tables and supplements to the existing clinical information system.

In the field of clinical informatics, a form of collaborative development where the end-user is invited to participate in design and iterative evaluation (particularly at the prototype stage of development) is termed user-centred development. Its importance is described by Nowlen et al [Nowlen 1994]. Nowlen outlines the difficulties of constructing intelligent clinical systems where understanding what the professionals need and understanding the techniques that can meet these needs has proved hard to master. One of the approaches Nowlen used in his own work includes user-centred development and supportive evaluation. Both of these concepts, Nowlen suggests, are seen as addressing the apparent problems of clinical systems failing to meet end-user requirements or being unusable in clinical conditions. Also in the field of medical informatics, Esterhay has focused on the use of metaphors to improve communication and, consequently, system usability. Metaphors are seen as an aid to the provision of prototypes which can be evaluated by all parties involved in the development process [Esterhay 1994]. Our metaphor vocabulary is extensive enough to describe both clinical and educational requirements in educational workstation development, is competent enough to provide support of consortia or group discussions, and is also used in the documentation produced in our development methodology to support iterative evaluation and discussion through the development process.

Collaborative development, user-centred design and the use of metaphors are all seen as catalysts for improved conceptualisation, communication, iterative evaluation, realisation and user appreciation.

Summary and Exploitation

We have discussed the importance placed upon the electronic book metaphor and the possibility of extending this in the form of a metaphor vocabulary which promotes a dialogue necessary for effective user-centred development. User-centred development is seen as potentially important for the development of integrated clinical CBI. At Velindre Hospital, we have taken advantage of this broad base of opinion spanning the research disciplines of educational computing and medical informatics to introduce a metaphor vocabulary supporting user-centred development within our knowledge management software.

At Velindre Hospital, we have employed a metaphor vocabulary to support the in-house development of a computer-based, multimedia awareness 'book' called ADV (Advisor) which promotes an integrated role for patient educational software. ADV is a male cancer advisory application used as an educational mediator between specialist cancer nurses and patients during counselling sessions. It informs male cancer patients about prostate, testicular and bladder cancers, clinical trials participation and aspects of male sexuality affected by cancer treatments, using video, sound, text and pictures. It also elicits information from patients about their preferences, concerns and expectations about their care, and produces tailored patient information documents. Patient feedback is stored as a supplement to the clinical information system. Collaborative development has comprised a specialist cancer nurse, CBI developer and has received input from clinicians specialising in cancer, and informaticians with knowledge of the information systems of the Hospital. The ability of a metaphor vocabulary to break down communication barriers between computer experts, the educational software developer and end-user has received encouraging responses. The ability of the metaphor vocabulary to define conceptual views of the application and the information resources of the hospital, (conceptual views which are common to the collaborative team regardless of computing expertise) has also been positively received. A full evaluation of this vocabulary is currently underway and early indications suggest that the metaphor vocabulary may be of particular benefit in allowing educational developers, clinical informaticians, commissioners and end-users to jointly conceptualise the specialised educational applications, and to conceptualise related concepts such as databases, entities, attributes, entity relationships and shared educational resource.

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A Method to Create Cognitive Conflict

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Abstract: The creation of cognitive conflict is one of the most effective ways to give learners' high motivation. Cognitive conflict can be created by providing a phenomenon which is different from a learner's idea or prediction: differences which are important to her/him. To use cognitive conflict for motivating learners, two factors are important: (1) the method to generate phenomenon, which includes differences for their ideas and (2) the ability to diagnose whether those differences are significant enough or not to create cognitive conflict. In this paper, first, we propose Error-Based Simulation (EBS) which is a method to create a behavior simulation reflecting an erroneous equation of a mechanical problem. We have confirmed, through experiments, when differences between EBS and a correct simulation weren't qualitative ones in "velocity" or "acceleration," a learner usually couldn't judge which behavior was correct. This paper also describes a diagnosis method of EBS with qualitative reasoning techniques.

1. Introduction

Motivation plays a crucial role in learning. The development of high motivation in learners is a key issue in education [Hatano 87]. Numerous investigations indicate that the creation of cognitive conflict is one of the most effective ways to give learners' high motivation. Cognitive conflict can be created by providing a phenomenon which is different from a learner's idea or prediction: differences which are important to her/him [Gagne 85, Osborne 85, Glynn 91] . Only differences which the learner can become aware of, arouse cognitive conflict. The learner is then motivated to correct her/his idea or prediction in order to dissolve the cognitive conflict.

To use cognitive conflict for motivating learners in a computer-based learning environment, two factors are important: (1) the method to generate phenomenon, which includes differences for their ideas and (2) the ability to diagnose whether those differences are significant enough or not to create cognitive conflict. We have proposed a method to create a behavior simulation reflecting an erroneous equation of a mechanical problem, in order to motivate learners to correct their errors [Hirashima 95a]. The simulation is called Error-Based Simulation (EBS). We have confirmed, through experiments, that EBS isn't always effective in arousing motivation for the correction of erroneous equations. In the experiments, learners who formulated erroneous equations were shown EBS. The results indicated that when differences between EBS and a correct simulation weren't qualitative ones in "velocity" or "acceleration," a learner usually couldn't judge which behavior was correct. In such cases, the learner's cognitive conflict was seldom aroused. For this simulation to be effective, EBS should be required to satisfy one or two conditions, "the qualitative difference in velocity" and/or "the qualitative difference in acceleration" [Hirashima 95b]

This paper describes a diagnosis method of EBS with qualitative reasoning techniques. First, by using qualitative simulation [Kuipers 86, Kuipers 94], the behavior of EBS is predicted and it is compared with the behavior of a correct simulation. When a qualitative difference is found, EBS is effective in arousing cognitive conflict. However, when qualitative differences aren't found, a parameter of which perturbation causes qualitative differences between EBS and a correct simulation is sought by using comparative analysis [Weld 88]. This qualitative difference is also useful in creating cognitive conflict. If this parameter cannot be found, EBS shouldn't be used.

Currently, a module which realizes the above management of EBS is implemented. This paper also discusses the effectiveness of EBS management through experiments.

2. Creating Cognitive Conflict with EBS

2.1 Methods to Create Cognitive Conflict

When learners' are corrected on their answers, it is not enough to simply tell them what the correct answers are.

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Learners often just accept the corrected answers without really understanding their meaning and frequently continue to repeat the same mistakes. To prevent the same mistakes from recurring, it is essential that learners become aware of the significance of the errors [Resnick 82, VanLehn 92, Laurillard 93]. Creating cognitive conflict is one of the most effective ways to motive learners to understand and to correct the errors.

Several computer-based learning environments, especially in physics, use simulations for creating cognitive conflict [Murray 90, White 93]. Here, cognitive conflict is created by showing a phenomenon which is different from a learner's erroneous prediction. The framework of this method is illustrated in Figure 1. In the framework, it is assumed that when the learner has an erroneous idea, she/he predicts an erroneous phenomenon reflecting that idea. Based on this assumption, to show the correct phenomenon, it is useful to create cognitive conflict. When the learner thinks the difference is important between the correct phenomenon and the erroneous one, which is predicted by her/him, cognitive conflict is aroused and she/he is motivated to correct the error. We call this method "Creating Cognitive Conflict by Correct-Mapping."

The above method is most effective when a learner predicts an erroneous phenomenon. A learner, however, doesn't always predict an inaccurate phenomenon when she/he has an inaccurate idea. The learner often knows a correct phenomenon in spite of her/his erroneous idea. For example, in Dynaturtle [diSessa 82], a learner operates "turtle" and tries to move it following her/his prediction. When the learner has an erroneous idea, she/he fails to control it. The differences between the correct phenomenon, which is predicted by her/him, and the generated phenomenon by operations, often arouse cognitive conflict. The framework of this method is illustrated in Figure 2. We call this method "Creating Cognitive Conflict by Error-Mapping." Several training environments with simulation, for example, STEAMER [Wenger 87], use this method to create cognitive conflict.

Most learning environments using this method, however, only deal with errors of parameters. All phenomenon generated in the environments are following correct laws. When a learner puts erroneous parameters in a simulator, she/he is usually presented with unexpected phenomenon. Although the unexpected phenomenon is different from the learner's expectation, it is correct for the parameters. Therefore, only one correct simulator is required in such learning environments. We call this type of error-mapping "Parameter-Error-Mapping." The framework is illustrated in Figure 3.

EBS, however, can deal with an erroneous equation of a mechanical problem. In general, an erroneous equation means an error of rules which control phenomenon. With this definition, a specific simulator is required to reflect the erroneous equation to phenomenon. This framework is illustrated in Figure 4. Equations in physics are rules of object behavior. A correct simulator which is developed to generate simulation using correct rules, cannot deal with erroneous equations. We have proposed EBS to generate simulation reflecting erroneous equations. In other words, in the framework of EBS, rules used to generate behavior are different in correct simulation. We call this type of error-mapping "Rule-Error-Mapping."

Simulations generating by Rule-Error-Mapping are unreal ones. Therefore, the use of Rule-Error-Mapping should be more careful than the use of Parameter-Error-Mapping, which generates real simulations. In this paper, we also describe a management module of EBS in addition to EBS itself.

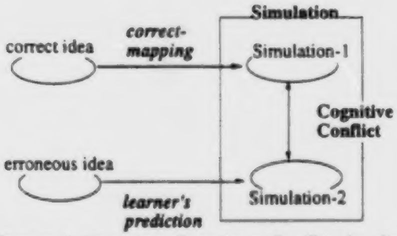

Simulation
correct idea
correct-mapping
Simulation-1
Cognitive Conflict
erroneous idea
Simulation-2
learner's prediction

Figure 1. Creating Cognitive Conflict by Correct-Mapping.

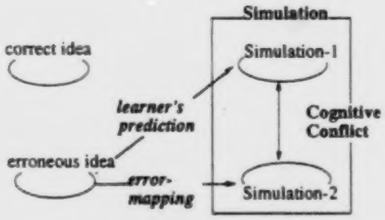

Simulation
correct idea
Simulation-1
learner's prediction
Cognitive Conflict
erroneous idea
error-mapping
Simulation-2

Figure 2. Creating Cognitive Conflict by Error-Mapping.

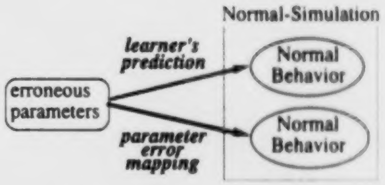

Normal-Simulation
learner's prediction
Normal Behavior
erroneous parameters
parameter error mapping
Normal Behavior

Figure 3. Parameter-Error-Mapping.

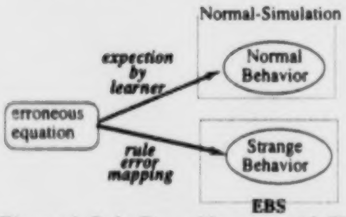

Normal-Simulation
expection by learner
Normal Behavior
erroneous equation
rule error mapping
Strange Behavior
EBS

Figure 4. Rule-Error-Mapping with EBS.

3. Error-Based Simulation and Its Management

3.1 Error-Based Simulation [Hirashima 95a]

EBS is generated by mapping an erroneous equation in formula-world to simulation-world. The EBS shows irregular behavior in contrast with the behavior of a correct simulation. The differences arouse cognitive conflict which motivates a learner to correct the error.

The method which reflects an erroneous equation onto the behavior simulation is called "Rule-Error-Mapping" (following simply called "error-mapping"). A mechanical component which can be set up as an equation of motion, such as a block, slope or platform-car, is called "object." Each object is given several equations constraining its mechanical attributes and behavior. These equations allow us to generate correct simulation. Currently, the error-mapping changes a value of a "velocity" or "acceleration" of an object by using the erroneous equation, and then generates EBS with the changed value. In the simulation, the object behaves in a strange manner and other objects behave normally.

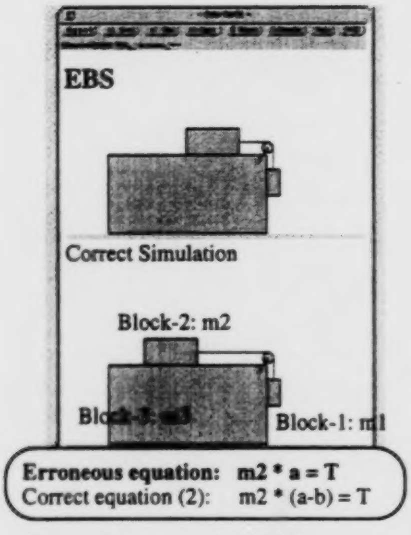
The procedure to generate EBS is divided as follows: (1) specifying an object to change the behavior (the object is called ER-object), (2) specifying an attribute to change its value for reflecting the erroneous equation (the attribute is called ER-attribute), (3) deriving the changed value (the value is called ER-value). When the dimensions of the unit system in the erroneous equation are wrong, it is impossible to calculate ER-value. Therefore, the coordination of the unit system in the erroneous equation is indispensable to generate EBS.

Figure 5 shows an example of EBS. The problem in Figure 5 is a three-blocks problem with one pulley. Each block can move without friction. Block-1 is restricted to move along the side of Block-3. A reactionary force exists between Block-1 and Block-3, and they move as one unit having a horizontal motion. When the vertical component of acceleration of Block-1 is "*a*" and the horizontal component of acceleration of Block-3 is "*b*," the horizontal component of acceleration of Block-2 is "*a-b*." Learners often formulate the erroneous equation "*m2*a=T*" for the horizontal movement of Block-2, instead of the correct equation "*m2*(a-b)=T*." The upper simulation in Figure 5 is the EBS for the erroneous equation and the lower simulation is the correct simulation. In the erroneous equation, the acceleration part is "*a*." It is used as the value of acceleration of Block-2. The correct value of acceleration of Block-2 is "*a-b*." In the EBS, Block-2 moves faster than in the correct simulation while Block-1 moves normally. Consequently, the distance between Block-1 and Block-2 is being narrowed. Because both EBS and the correct simulation are shown at the same time, learners can compare them easily.

The authors confirmed EBS was effective to correct these erroneous equations for learners through an experiment. However, for other problems and errors, EBS doesn't always visualize an error clearly. Therefore, a management function for EBS is required.

3.2 Requirement for EBS Management

The above procedure to generate EBS doesn't pay attention to the kinds of differences from a correct simulation.



Erroneous equation: m2 * a = T
Correct equation (2): m2 * (a-b) = T

Figure 5. An example of EBS.

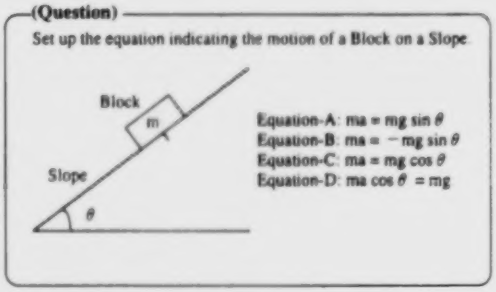

(Question)
Set up the equation indicating the motion of a Block on a Slope
Block
m
Slope
θ
Equation-A: ma = mg sin θ
Equation-B: ma = − mg sin θ
Equation-C: ma = mg cos θ
Equation-D: ma cos θ = mg

Figure 6. An Example of Mechanics Problem.

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Occasionally, EBSs which aren't useful to visualize errors are generated. In Figure 6, when a learner sets up Equation-B as an equation of motion of the Block, the EBS based on Equation-B shows the Block ascending the Slope. The correct simulation based on Equation-A shows the Block descending the Slope. In this example, EBS visualizes the error clearly. When a learner sets up Equation-C, the EBS based on Equation-C only shows the Block moving in the same direction along the Slope as the correct simulation, but with a slightly different velocity and acceleration. In this case, it is difficult for the learner to judge which behavior is correct. For Equation-C, EBS shouldn't be used directly. However, when the angle of the Slope Ø increases, velocity and acceleration in the EBS decrease while in a correct simulation they increase. Such noticeable changes in behavior enable the learner to recognize the error.

Through these examples, in order to visualize an erroneous equation clearly with EBS, the authors assumed that EBS should include qualitative differences in "velocity" and/or "acceleration" against a correct simulation. Based on this assumption, an EBS-manager is required, as described below:

(1) EBS-manager can analyze the behavior of both EBS and a correct simulation qualitatively. It can also judge whether or not there is a qualitative difference in velocity or acceleration between them.

(2) When there aren't any qualitative differences, the EBS-manager can search for a parameter of which perturbation causes a qualitative difference in velocity or acceleration between EBS and a correct simulation.

Qualitative reasoning techniques are used to realize the EBS-manager. Before explaining its mechanism in detail, "qualitative differences" which contribute to recognizing errors are defined as follows:

Definition-1: There is a "qualitative difference" between two objects' behaviors when the qualitative values, (e.g., "plus," "zero" and "minus,") of velocity or acceleration of the objects, are different. For example, in Figure 6, the qualitative values of the velocity and acceleration of the ascending Block in the EBS based on Equation-B are "minus," while the qualitative values of the velocity or acceleration of the descending Block in the correct simulation based on Equation-A are "plus." Therefore, there is a "qualitative difference" between the EBS based on Equation-B and the correct simulation based on Equation-A.

Definition-2: There is a "qualitative difference" between two objects' changes in behaviors when the qualitative values, (e.g., "increasing," "steady" and "decreasing,") of the ration of their velocity or acceleration changes to a parameter's change (except time) are different. The qualitative values are called "qualitative directions." For example, in Figure 6, the velocity and acceleration of Block in EBS based on Equation-A increases when the Angle of the Slope Ø increases. When this happens, the qualitative directions of the velocity and acceleration are "increasing." The velocity and acceleration of Block in EBS based on Equation-C decrease when the Angle of the Slope Ø increases. Therefore, the qualitative directions of the velocity and acceleration are "decreasing." When this occurs, there is "qualitative difference" between the EBS based on Equation-C and the correct simulation based on Equation-A when the Angle of the Slope changes.

3.3 EBS-manager

The management process of EBS is divided into two phases. In Phase-1, the EBS-manager compares the qualitative behavior of the EBS with the one of a correct simulation. When a qualitative difference is found, the EBS-manager judges that the EBS is effective in arousing cognitive conflict and shows the EBS to a learner. When a qualitative difference cannot be found, it proceeds to Phase-2. In Phase-2, the EBS-manager tries to find a parameter of which perturbation causes a qualitative difference between the EBS and a correct simulation. When such a parameter cannot be found, the EBS-manager judges that the EBS shouldn't be used to create cognitive conflict.

3.3.1 Phase-1: Qualitative Simulation

First, the EBS-manager predicts qualitative behavior of the EBS by using QSIM [Kuipers 94]. The behavior is then compares with qualitative behavior of a correct simulation similarly predicted by qualitative simulation. When a qualitative difference is found, the EBS-manager judges that the EBS is effective in creating cognitive conflict.

QSIM derives the qualitative states consisting of the "qualitative value of velocity" and the "qualitative value of acceleration" based on an equation. For Equation-A, that is correct equation, both values are positive. In contrast, both values of Equation-B are negative. Qualitative differences are found between the behaviors of Equation-A and Equation-B. Therefore, the EBS-manager judges that EBS for Equation-B is effective.

3.3.2 Phase-2: Comparative Analysis

When a qualitative difference cannot be found by using QSIM, the EBS-manager tries to find a parameter by using comparative analysis [Weld 88] of which perturbation causes a qualitative difference between the EBS and a correct simulation. When such a parameter cannot be found, the EBS-manager judges that the EBS shouldn't be used to create cognitive conflict.

For Equation-C, the EBS-manager cannot find any qualitative difference between the EBS based on Equation-C and a correct simulation based on Equation-A by QSIM. In this case, by using comparative analysis, Ø is found as a parameter of which perturbation causes qualitative difference between the EBS based on Equation-C and a correct simulation based on Equation-A. Increasing Ø increases acceleration of the Block in the correct simulation, while increasing Ø decreases acceleration of the Block in the EBS.

For Equation-D, the EBS-manager cannot find any qualitative difference between the EBS based on Equation-D and the correct simulation based on Equation-A, by qualitative simulation. In spite of comparative analysis, no parameter is found as a parameter of which perturbation causes qualitative difference between the EBS based on Equation-D and a correct simulation based on Equation-A. In such a case, the EBS-manager judges that the EBS shouldn't be used to visualize the error. The way to treat this case is discussed in the next section.

4. Experiment

The EBS-manager has been developed on Sun SPARCstation10 with Japanese Open Windows Ver.2.0.1 and Lucid Common Lisp. Its effectiveness was evaluated through an experiment. Using the problem shown in Figure 6, EBSs for the erroneous equations (Equation-B, Equation-C, Equation-D) were shown to ten subjects who were college students in the engineering department. In each EBS case, the subjects were shown both the EBS and a correct simulation at the same time and were asked two questions: (1) could they judge which behavior was correct, and (2) did they feel the EBS was useful in motivating a learner to correct the error in the equation. Figure 7 is the example shown to the subjects where the EBS and a correct simulation were shown at the same time. The upper simulation is the EBS based on Equation-B. The lower simulation is the correct simulation based on Equation-A.

In the case of Equation-B, by qualitative simulation, the EBS-manager judges that the EBS is effective because it has qualitative differences from a correct simulation based on Equation-A. The EBS-manager shows the actual EBS to the subjects. Observing the EBS in which the Block was ascending the Slope, all the subjects recognized the strangeness in the EBS and could judge which behavior was correct. They also answered that this EBS was useful in motivating a learner to correct the error. This result suggests that the EBS is a promising method to create cognitive conflict for the error.

In the case of Equation-C, by qualitative simulation, the EBS-manager judges that the EBS isn't effective because it doesn't have any qualitative difference from a correct simulation, based on Equation-A. By comparative analysis, the EBS-manager finds Ø as the parameter of which perturbation causes qualitative difference between the EBS and a correct simulation. The EBS-manager instructs the subjects to change the Ø by direct manipulation, and generates the EBS and the correct simulation with the changed Ø. Observing the EBS in which increasing Ø decreases acceleration of the Block, all of the subjects recognized this strange phenomenon and could judge which behavior was correct. Eight of the subjects answered that this EBS was useful in motivating to correct the error. Two subjects answered that the EBS wasn't useful, indicating that the interface of the system should be improved to show the two EBSs, one being the original EBS and the other being the EBS with changed Ø, simultaneously. However, even these two subjects said the idea of the EBS is useful. These results suggest that the modified EBS is a promising method to help a learner correct his/her erroneous equation.

For comparison, the original EBS based on Equation-C with fixed Ø was shown to the subjects and all of them failed to judge which behavior was correct. They answered that this EBS wasn't useful in understanding an error. This fact indicates the importance of the EBS-manager.

In the case of Equation-D, the EBS-manager cannot find any qualitative difference either by using qualitative simulation or by using comparative analysis. Currently, the EBS-manager judges that the EBS isn't useful to visualize the error in Equation-D. The subjects were asked whether they had any suggestions: three of them

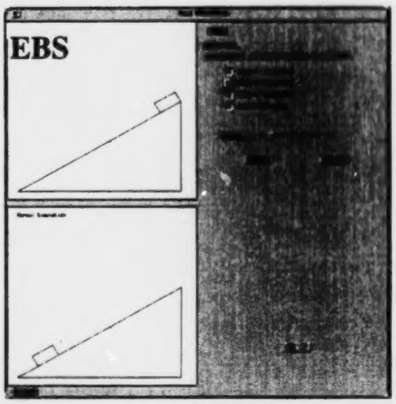

Figure 7. Example of EBS Shown to the Subjects.

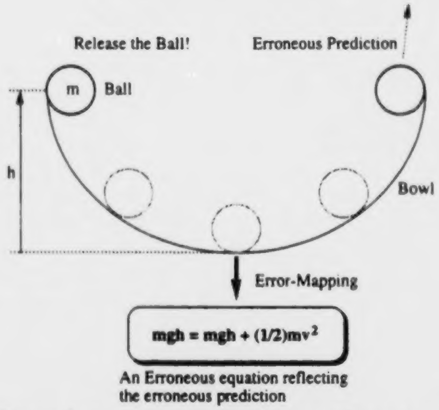

Figure 8. An Erroneous Prediction of Behavior and the Erroneous Equation Reflecting the Prediction.

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indicated that changing the Ø down to zero (meaning Flat Floor) or up to 90 degrees (meaning Vertical Wall) causes a qualitative difference. When Ø becomes zero, the Block still moves at gravity acceleration in the EBS based on Equation-D, while the Block doesn't move any longer in a correct simulation based on Equation-A. When Ø becomes 90 degrees, the Block falls down at infinite acceleration in the EBS based on Equation-D, while the Block falls down at gravity acceleration in a correct simulation based on Equation-A. Although these are qualitative differences, changing a parameter to its limit cannot be treated by EBS-manager because DQ analysis treats only the perturbation that doesn't change in behavioral topology. Improving EBS-manager to be able to treat such cases is an important future work.

5. Conclusion Remarks

We describe a method to create cognitive conflict and its management. EBS is a behavior simulation reflecting an erroneous equation for a mechanical problem. The differences between EBS and a correct simulation visualize the error and arouse cognitive conflict. EBS-manager diagnoses and modifies EBS in order to use EBS effective with qualitative reasoning techniques.

One of the major future works indicated is to realize error-mapping from behavior prediction to equation. There are several cases in which it is more effective to map an error in behavior prediction to create cognitive conflict. This fact is explained with an example shown in Figure 8. A learner often predicts that the Ball released at the left edge of the Bowl jumps out of Bowl at the right edge. This is wrong. In this example, it is easier to explain the reason why the predicted behavior is wrong by using an equation. The explanation is as follows: a learner easily understands that the whole energy of the Ball at the left edge is "mgh", and she/he also easily understands that the potential energy of the Ball at the right edge is "mgh" because it is at the same height. However, if the Ball jumps out of the Bowl at the right edge, it must have the kinetic energy "(1/2)mv^2". As a result, a strange equation "$mgh = mgh$ + (1/2)mv^2" is derived where the energy of the Ball isn't conserved. The learner can then understand that his/her prediction is wrong by the equation more easily than by the behavior simulation.

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Multimedia Learning Environment in Statics

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Abstract: We are developing a learning environment in the subject area of statics that combines physical experiments, interactive multimedia, and cooperative learning in the framework of experience-based learning [Kolb, 1984]. Statics is concerned with the computation of forces acting on bodies (solids or fluids) in equilibrium. The course is designed to promote the active engagement of students in learning. A review of the literature, which supports these activities, is presented and some multimedia learning modules are illustrated. We are using Authorware Professional to construct the multimedia program.

Introduction

> *...for the computer to bring about a revolution in higher education, its introduction must be accompanied by improvements in our understanding of learning and teaching.* Nobel Laureate Herbert Simon [Kozma and Johnston, 1991]

Simon's statement has been a reassuring theme in our search of principles and strategies for active learning to guide the design of a multimedia learning environment for statics. In the process, the course has evolved into a workshop style environment [Laws, 1991] that combines physical experiments, interactive multimedia, and cooperative activities in the context of experiential learning [Holzer and Andruet, 1996]. We are increasing physical experiments, developing new multimedia modules, and planning a service project to extend "learning by doing" [Dewey in Brooks and Brooks, 1993] from the classroom to the community.

In this paper we provide a background for experiential and cooperative learning, illustrate some multimedia learning modules, and present some preliminary results from a workshop learning environment.

Experiential Learning

> *Learning is the process whereby knowledge is created through the transformation of experience.* [David Kolb, 1984]

Experiential learning, which is modeled after the scientific method, has its roots in the works of Dewey, Lewin, and Piaget [Kolb, 1984]. It focuses on the central role that experience plays in the learning process. Moreover, "learning from experience is the process whereby human development occurs" [Vygotsky in Kolb, 1984].

Although experience is essential to learning, it is not enough; one has to do something with it to construct knowledge [Piaget, 1954; Bringuier, 1980; Holzer, 1994]. This is reflected in Kolb's experiential learning model [Fig. 1], which displays the two fundamental activities of learning: grasping and transforming experience.

Each activity involves two opposite but complementary modes of learning. One can grasp an experience directly through the senses (sensory, inductive mode) or indirectly in symbolic form (conceptual, deductive mode). Similarly, there are two distinct ways to transform experience, by reflection or action. At any moment in the learning process, one or a combination of the four fundamental learning modes may be involved. It is significant that their synthesis leads to higher levels of learning [Kolb, 1984]. We found it helpful to view the four-stage learning cycle as a spiral in time that extends beyond a session. For example, a concept or principle may be developed or applied in different contexts, at different times, and through different learning modes.

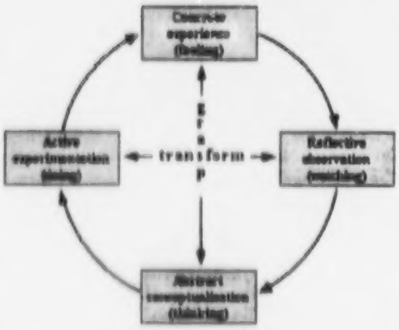
Concrete experience (feeling)
Reflective observation (watching)
Abstract conceptualization (thinking)
Active experimentation (doing)
transform
grasp

Figure 1. Experiential learning model

Cooperative Learning

> *...early evidence suggests that students who work in small groups, even when interacting with high-tech equipment, learn significantly more than students who work primarily alone.* The Harvard Assessment Seminars [Light, 1990]

Cooperative learning is not a new concept [Ercolano, 1994]. Extensive research, initiated in the late 1800s, has demonstrated significant advantages of cooperative learning over competitive and individualistic learning in various learning characteristics; these include [Johnson et al., 1991]: high-level reasoning; generation of new ideas and solutions; motivation for learning; personal responsibility; and student retention.

Cooperative learning provides structures [Kagan, 1990] to engage students in meaningful activities that can be shared with others [Papert and Harel, 1991]. Meaningful activities include authentic activities that represent future tasks and problems and are rich in learning resources [Beichner, 1993]. Kagan [1990] encourages teachers to use a range of structures to enhance their usefulness in the cognitive and social learning of students.

We have been experimenting with some structures and have found think-pair-share [Lyman, 1987; Habel, 1996] and variations of pair activities effective in the classroom: Students **think** about a problem individually to organize their thoughts; they form **pairs** to share and discuss their solutions; they **share** and discuss their findings with another pair or a larger group. It is encouraging to receive positive minute paper [Cross, 1991] feedback from students: "I think our group works well together. I have learned a lot from working with them." "I realized how much more I learn when I help people."

Learning Environments

> *I see more clearly than before that the path to motivating students is the joy of creation, exploration, and discovery. I see also that these processes are social in nature and that shared experiences in class and through teamwork projects are vital.* [Shneiderman ,1993]

We taught and evaluated a section of statics in the workshop format for the second time last fall. We met in computer labs where two students shared one computer. A session was generally divided into three parts: (1) We started with short group activities, a warm-up problem, to focus on problems or questions that surfaced in homework, weekly quizzes, or minute papers; (2) this was followed by mini lectures (10 - 15 minutes long) and cooperative activities; (3) at the end of the session, students were asked to reflect and answer questions about the day's lesson and activities (minute paper). Our learning resources included physical models of simple structures, a multimedia program that was used in lectures and group activities, pencil and paper for manual activities, and a board to aid discussions.

The biggest challenge, especially in the first course, was to achieve a good balance among various activities. This is crucial for students who are not highly motivated or skilled learners; a rich, active learning environment can become overwhelming. This potential problem can be reduced as follows: (1) Give students the opportunity to master one unit of learning modules before moving to the next [Terenzini and Pascarella, 1994]; (2) frequently place learning modules in context of the course framework and objectives, the students' background, and real engineering problems; and (3) provide frequent feedback. It is also important to stress the students' responsibility for learning and the benefits of helping one another learn.

In the second course, the students adapted quickly to the new learning environment. The following comments selected from minute papers reflect their attitudes: "Groups/pairs are great to work in." "Good to have a few minutes to think/reflect before conversing with partner." "Interesting learning concept; good to be part." "Computer and partner interaction makes class seem easier. More ideas are aired with this environment." "The group activities allow for personal interaction and verbal comparison. Then reverting to the computer to see the answer and diagram really helps." "Computer is very user friendly and set up well for learning." "The computer diagrams really helped me to understand the concept of components." "The program that we are using is so easy to operate and understand. Technology, isn't it wonderful." "I feel like I am getting a good grasp on the material." " Seeing it on the computer helps so much." "I enjoyed answering the questions of my partner." "I am actually enjoying this class."

Multimedia Learning Modules

Figure 2 introduces a two-part session where students first develop the principle of transmissibility and then apply it to compute member forces in trusses. The development of transmissibility involves the first three stages of experiential learning [Fig. 1], called in this context experiment, analysis, and transmissibility.

1. **Experiment.** Students work in pairs to determine the tensile force in member 2 [Fig. 2] and indirectly the compressive force in member 1 [Fig. 3]. This approach was motivated to find an inexpensive way to measure the compressive force in a physical model of a truss; a compression force meter costs about 10 times as much as a spring scale.

2. **Analysis.** Free-body diagrams (FBDs) are constructed of joint c to observe that the joint can be balanced either by the compressive force applied by member 1 [Fig. 4] or the tensile force applied by the spring scale on the other side of the joint [Fig. 5]. The objective is to discover that one can move a force along its line of action without disturbing equilibrium (the principle of transmissibility). The Note and force resolution appear in Fig. 4 if the value for F_1 is entered twice incorrectly and in Fig. 5 if "no" is entered in response to the question "Is joint c in equilibrium?"

Further details about this two-part session are presented in the electronic version of the paper.

Summary

Workshop Statics, a laboratory-based learning environment for statics, is being developed. It includes physical experiments, group activities, and interactive multimedia in the framework of experiential learning. This learning environment is described, and some learning modules from a session on trusses are presented.

Acknowledgment

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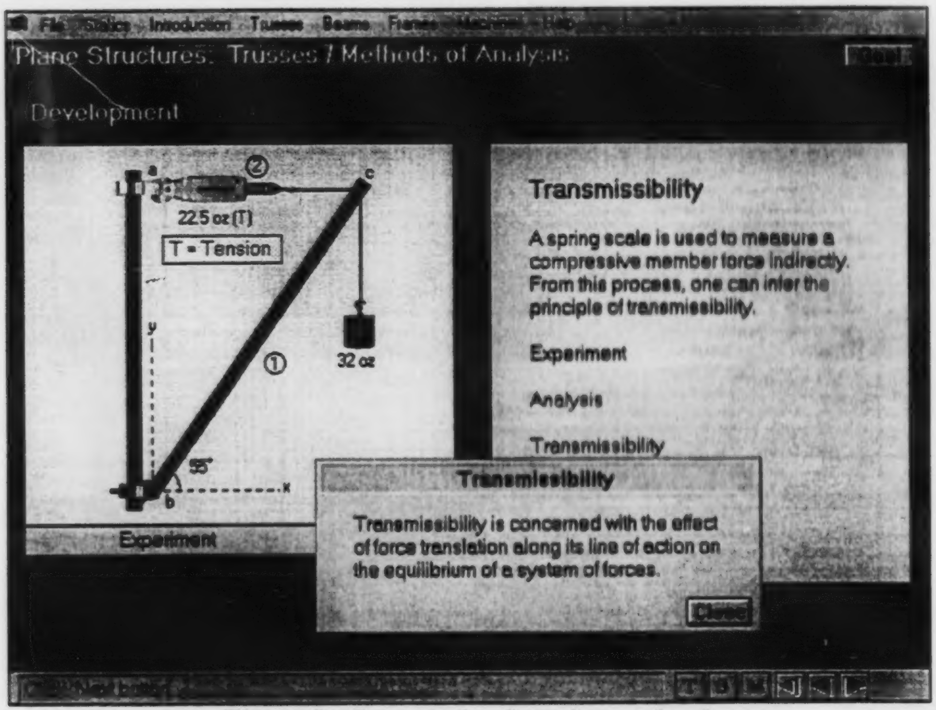
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Statics
Introduction
Trusses
Beams
Frames
Machines
Help
Plane Structures: Trusses / Methods of Analysis
Goal
Development
a
②
c
22.5 oz (T)
T = Tension
y
①
32 oz
55°
x
b
Experiment
Experiment
Analysis
Transmissibility
Close

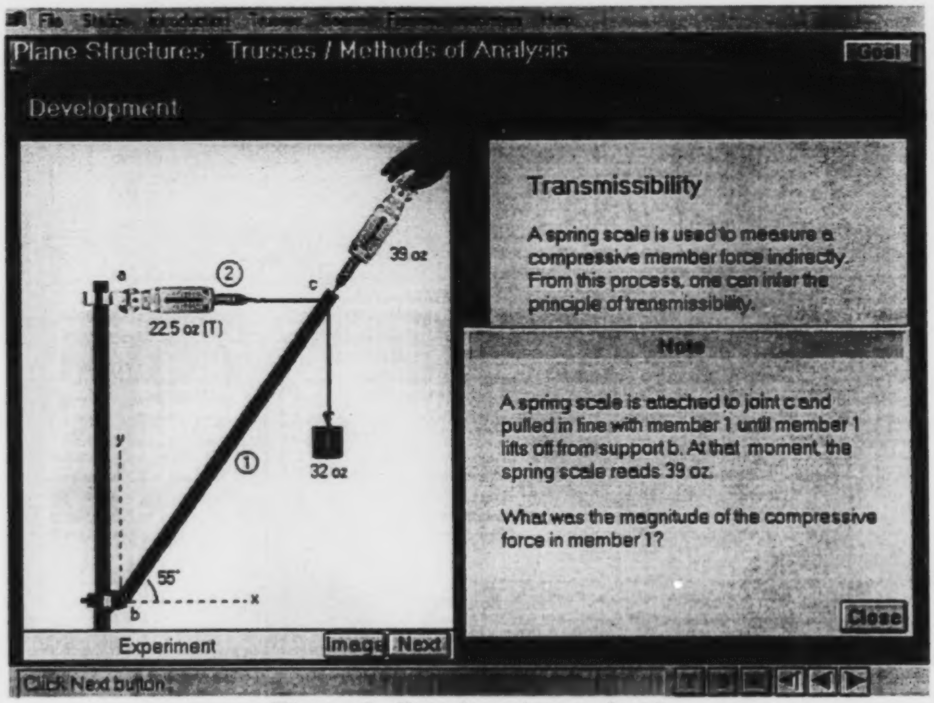
Transmissibility

A spring scale is used to measure a compressive member force indirectly. From this process, one can infer the principle of transmissibility.

Transmissibility

Transmissibility is concerned with the effect of force translation along its line of action on the equilibrium of a system of forces.

Figure 2. Compressive force in member 1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39 oz
a
②
c
22.5 oz (T)
y
①
32 oz
55°
x
b
Experiment
Image
Next
Note
Close
Click Next button

Transmissibility

A spring scale is used to measure a compressive member force indirectly. From this process, one can infer the principle of transmissibility.

A spring scale is attached to joint c and pulled in line with member 1 until member 1 lifts off from support b. At that moment, the spring scale reads 39 oz.

What was the magnitude of the compressive force in member 1?

Figure 3. Zero force in member 1

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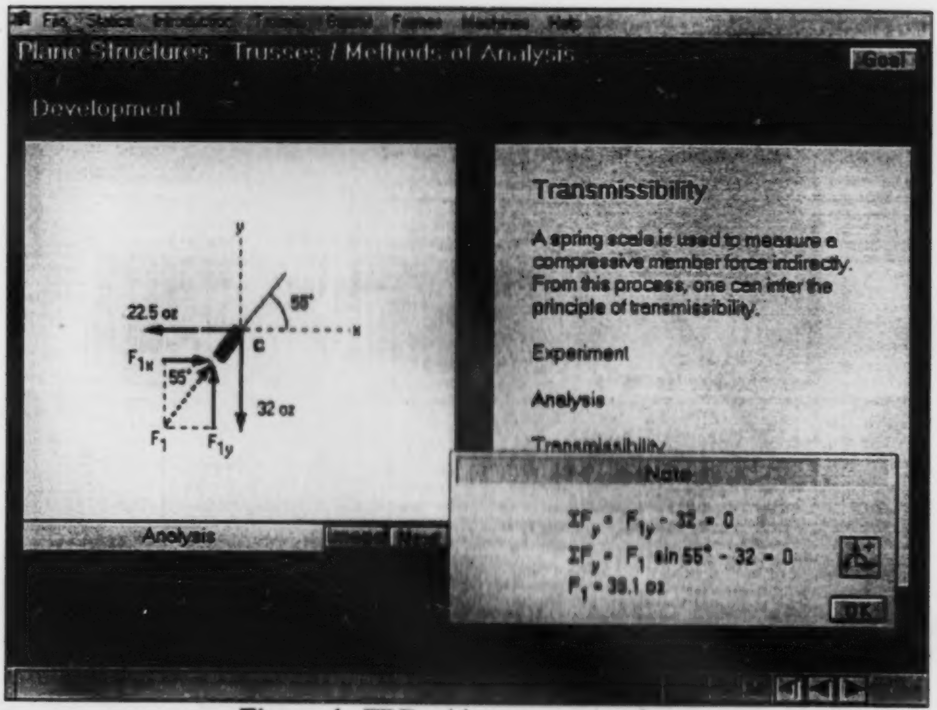
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y
x
55°
22.5 oz
c
F_{1x}
55°
32 oz
F_1
F_{1y}
Analysis
Next
Note
OK

Transmissibility

A spring scale is used to measure a compressive member force indirectly. From this process, one can infer the principle of transmissibility.

Experiment

Analysis

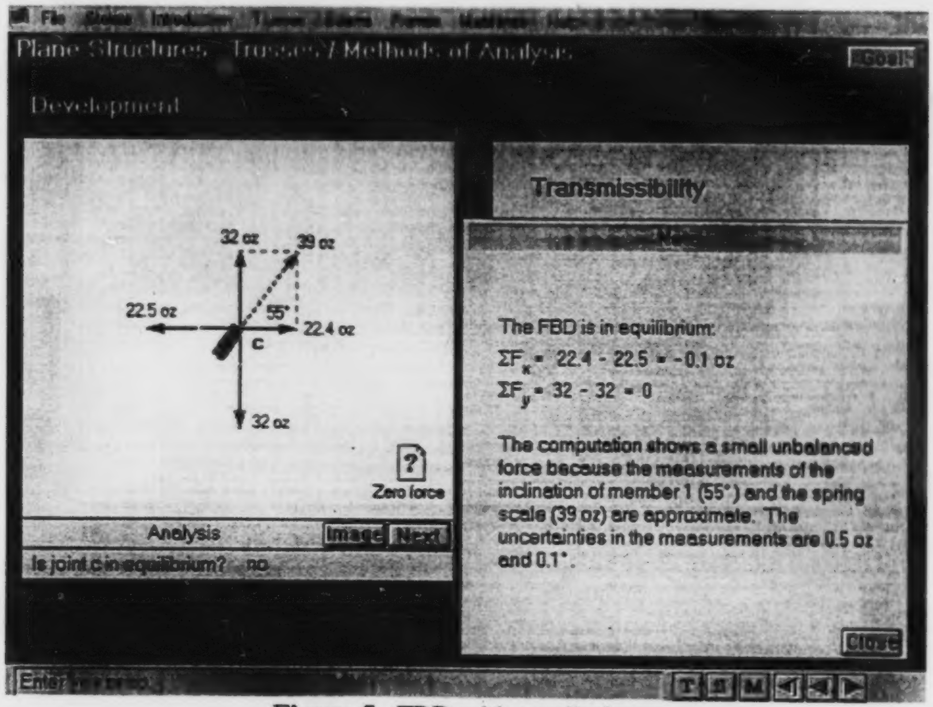
Transmissibility

$\Sigma F_y = F_{1y} - 32 = 0$

$\Sigma F_y = F_1 \sin 55° - 32 = 0$

$F_1 = 39.1$ oz

Figure 4. FBD with compressive force


File
Statics
Introduction
Plane Structures Trusses / Methods of Analysis
Goal
Development
32 oz
39 oz
22.5 oz
55°
22.4 oz
c
32 oz
?
Zero force
Analysis
Image
Next
Note
Close
T
S
M

Transmissibility

Is joint c in equilibrium? no

The FBD is in equilibrium:

$\Sigma F_x = 22.4 - 22.5 = -0.1$ oz

$\Sigma F_y = 32 - 32 = 0$

The computation shows a small unbalanced force because the measurements of the inclination of member 1 (55°) and the spring scale (39 oz) are approximate. The uncertainties in the measurements are 0.5 oz and 0.1°.

Figure 5. FBD with tensile force

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PLANNING FOR TECHNOLOGY INTEGRATION - A STRATEGIC FIT

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Abstract

Technology integration plans must demonstrate a strategic fit between institutional goals and those of the technology plan. Ideally, the technology plan will flow naturally out of the strategic institutional plan. This paper outlines a planning process useful to assist institutions in planning for technology integration. It describes a participatory process which builds on institutional contexts and reflects institutional values. It is a process that builds institutional support and ownership, with the capacity to be self-sustaining and responsive to a changing environment.

INTRODUCTION

Educational leaders have a responsibility to make decisions which establish purposes, goals, objectives and outcomes of their educational enterprise; they design the mechanisms by which goals will be achieved; and, they develop procedures for monitoring and evaluating achievement of those goals.

In institutions where actions align with these decisions, progress is made with clear focus and purpose. In educational systems where misalignment occurs between goals and actions, results are demonstrated in short-lived innovations, obsolete curriculum, and incompatible instructional and organizational practices and policies.

Increasingly, the public demands that educational institutions demonstrate decision-making processes and implementation strategies which are responsive to public need and accountable to public scrutiny. Economic realities and technological challenges are rapidly reducing both society's and government's tolerance for educational systems that have actions that do not seem to fit with what its stakeholders value.

In the province of Alberta, many of the thirty post-secondary educational institutions are currently involved in developing institutional technology integration plans in response to the Government of Alberta's recent initiative to create a $30 million funding envelope dedicated specifically to enhance the province's adult learning system through the application and use of communications and information technologies. These technology integration plans must demonstrate a strategic fit between institutional goals and those of the technology plan. Ideally, the technology integration plan will flow naturally out of the strategic institutional plan.

This paper outlines a planning process useful to assist institutions in planning for technology integration. It describes a participatory process which builds on institutional contexts and reflects institutional values. It is a process that builds institutional support and ownership, , with the capacity to be self-sustaining and responsive to a changing environment.

ORIENTATION TO TECHNOLOGY INTEGRATION

Technology is defined by its use. In an applied field such as education, the worth of instructional and learning technologies has been determined and measured by their practical application. This estimation of worth is determined by the user. So it is with technology integration plans. Their worth will be determined by users and by their "fit" with whatever teaching/learning views users hold.

What learners and practitioners value will determine how technology is used. And those who value technology in education hold that technology is one of the best mediums available to improve instruction, increase accessibility, increase interactivity, empower students, and at the same time, constrain ever-rising costs. It follows from this perspective, then, that technology is regarded as a tool that has the capacity to change how teaching and learning happen within an organization.

In most cases, educational institutions want and expect technology to be catalyst for change, and a vehicle to make those changes happen. There is an expectation that learning and instruction will improve with technology, that opportunities for learning will be increased, and that barriers and limitations to access will be reduced. There is an expectation that technology will change the culture of learning.

It is not surprising, then, that much time and effort should be devoted to planning for technology integration in a manner that ensures institutional values are recognized and that they direct how the technology integration plan will be realized.

APPROACH TO THE PLANNING PROCESS

Generically, strategic planning involves knowing where you are at as an institution, then planning for where you, as an institution, want to be--usually three to five years into the future. Components of a strategic plan may vary, but generally they include an assessment of the forces external to the institution that influence and have the potential to impact the institution's plan; an examination of the internal institutional environment, including its mission and goals statements, current and previous business plans, formal and informal planning documents, organizational structure and culture (climate), and resources; an assessment of needs (staff, student, administration, and community); and, a determination of both long-range and short-term goals and objectives for the institution.

This kind of strategic planning process, one we have found to be successful, necessarily involves flexibility and includes growth and changes. As technologies change, so do the requirements for students, for administration, faculty, support staff, curriculum and resources. The challenge for educational planners is to provide an environment that enables and supports changing learning and teaching processes.

Our approach to facilitating technology integration planning is based on our knowledge and understanding of instructional design, policy planning and educational leadership. We believe the planning process can be a valuable and constructive learning experience for all participants. We work closely with those assigned the task of planning and preparing the planning technology integration document--usually an internal Technology Integration Planning Committee. Together, as a planning team, we establish a framework from which to view technology integration and from which to highlight environmental, organizational, resource and support considerations which impact successful implementation of the plan. We find that this strategy builds commitment to the process and ownership of the final outcome.

What follows is a strategy for successful technology integration planning:

STAGE ONE - SETTING GOALS AND OBJECTIVES

The first step in the planning process is to clearly articulate, or have available, clearly articulated institutional goals. These evolve out of what institutional leaders, participants, and stakeholders value. Technology integration planning processes often involve a questioning of the fundamental vision statement of the institution to determine what is really valued, what it is that the institution wants its teachers and learners to take away with them when they leave the institution. What knowledge, skills, attitudes and values does the institution within its larger educational community believe its clients should learn?

The vision and mission statements of the institution form the foundation for the technology integration plan. For example:

STATEMENT OF CORPORATE VALUES AND BELIEFS

These statements are intended to act as the foundational principles on which the organization intends to base its planning processes, goals, objectives and strategies to achieve those objectives.

Here are a few generic examples:

We value quality, therefore,
we will provide services and resources which are reliable, relevant, and cost-effective.

We value success, therefore,
we will measure individual and group efforts and recognize successes.

We value resourcefulness, therefore,
we will optimize use of existing and potential resources, services and expertise.

STAGE TWO: DETERMINING ORGANIZATIONAL STRUCTURES AND SUPPORTS

A cursory profile of the institution's organizational structure, programs and current technology resources can usually be constructed through a review of institutional documents. Reviewing reporting lines and main service units is also important.

A review of the institution's current capacity to resource and support extensive technology integration is required. This includes an overview of current technologies in use or soon to be in use, as well as an assessment of institutional learner and staff support services. Curriculum development and delivery mechanisms should be examined. In addition, the institution's past accomplishments in technology integration should be documented.

Institutional documents and service units to review may include:
Mission Statement
Organizational Chart(s)
Business Plan(s)
Previous Planning Minutes
Facility Services
Planning Services
Computer/Learning Technology/Library Services

Student Services

An evaluation of program needs should specify the level of student access to technology resources that must be provided to meet student needs, as well as minimum entry-level competency and skill sets. This evaluation should include numbers of courses and programs, numbers of students enrolled in courses and programs, completion rates, and the amounts and types of resource requirements (including human resources) needed to successfully support courses and programs.

An institution should also carefully assess the ways in which it is currently using various information technologies in instruction so that it can plan to meet projected needs from the basis of current capacity.

An inventory of existing resources is required to identify deficiencies and redundancies. An assessment of resource supports should include a comprehensive inventory of the resources that the organization/institution already possesses that can be applied to assist faculty to teach and students to learn, recognizing that teaching and learning are to certain degrees reciprocal processes. Such an inventory should catalogue not only current technology resources, such as the number and type of hardware and software, but also other supporting resources, including technical staff, programming support, related media and library resources, computing capacity, faculty and staff expertise, and training materials.

STAGE THREE: DEFINING ORGANIZATIONAL CULTURE

Following a reading of the mission and foundational statements, organizational structure and supports, a critical step in strategic planning for technology integration is to determine the needs and perspectives of students, faculty, professional staff, support staff, and administration. Since technology integration can be viewed from many perspectives, it is important to assess the range of perspectives as they exist across institutional staff, management and executive.

Most often we conduct focus group sessions with instructors, students, executive and community members, for instance. Interaction and exchange among participants is important and useful to clarify issues, to understand competing points of view, and, where possible, to reach consensus. While gathering data for this stage, we invite participants to discuss the institutional context, climate, and organizational structure which will influence technology integration at the institution. Issues which emerge from these discussions are addressed with the Planning Committee. Together with an analysis of the organizational supports, this information is used to form the foundation on which the goals and objectives of the Technology Integration Plan evolve.

At the institutional level, faculty may assist in advising which skills students need to be successful in academic studies, in workplace performance, and in social/cultural development. These skills are usually specified in terms of credentials and competencies required for program completion. And although skill requirements should be reviewed regularly, constant review is essential when integrating technological skills, since these skills change so quickly. Updates and revisions to program requirements should clearly address levels of technology skills and competencies for each program.

An assessment of the skills required of students to succeed in an increasingly technological and competitive workforce can also be determined with assistance from prospective employers and employment agencies.

At the individual level, students should have input into determining their needs. Education and training should be done in consultation with students. With increased expectations being placed upon students to take more responsibility for accessing and managing their own learning, students need to have opportunities to express their needs, which should then serve to inform decision-making processes regarding the development of programs. Students can give vital information as far as what they perceive to be their levels of readiness, and capacity for manipulating new knowledge and skills.

Faculty and staff needs should be considered in terms of the skills and resources they require to assist students to achieve learning objectives. As methods of instruction are affected by technology, faculty and staff need to develop the competencies and skills to be able to use technology resources effectively in their practice.

Determining faculty needs is a complex process that relies heavily on faculty and staff to identify their own needs for training as well resources to facilitate training and instruction. While there can be no substitute for the input of professional faculty, professional staff, and support staff, some care must be taken to separate needs from wants.

STAGE FOUR: ALIGNING TECHNOLOGY INTEGRATION GOALS AND OBJECTIVES WITH INSTITUTIONAL GOALS

The alignment of the institution's overall strategic plan with the proposed Technology Integration Plan is imperative. Technology should support the institution's mission, goals and objectives, not determine them. Guided by the Strategic Plan, we customarily facilitate a session with the Planning Committee to develop a clearly articulated mission for technology integration, including the goals and objectives. This preliminary foundation directs all subsequent technology integration action plans. The Technology Integration Plan should have a foundational statement.

The following is an example:

"The College will use information technology effectively to create and support accessible and purposeful education and training opportunities designed to empower learners with the knowledge and skills to meet the challenges of the 21st century."

It is from the foundation statement that long-range goal and short-range objective setting can be written. These goals and objectives serve as guideposts to monitor and to evaluate progress.

It is important to recognize that developing goals and objectives for integrating information technology must take place within the context of other organization/institution planning processes. Only some of the goals and objectives established for the organization/institution as a whole, will be pertinent to information technology integration. When the goals and objectives of the institution are not congruent with the technology integration goals and objectives, it may be necessary to change previously stated goals and objectives to reconcile with changing technology and environmental conditions.

Once the long-term goals for information technology integration are established (achievable over the next three to five years), specific short-range objectives covering one to two years can be outlined. These objectives are then developed into specific projects and implemented as part of the operational component of the Technology Integration Plan.

Short-range objectives must be specific enough to be measurable. They are the final piece of the strategic plan that provides the specificity necessary to create projects which assign tasks, allocate resources and indicate the person, persons, or units responsible for conducting activities that lead to the accomplishment of definable outcomes.

The following are examples of goals and objectives:

Value: We value equality, therefore, we will strive for universality of resources and services.

Goal: Having equitable, effective and efficient information technology connectivity between all campuses.

Objective: To provide all campuses with baseline standards of telecommunications connectivity.

Action: Establish baseline standards of connectivity across all campuses.

Action: Assess each campus for connectivity needs (hardware, software).

Action: Prepare 3-5 year plan to implement telecommunications connectivity.

STAGE FIVE: DEVELOPING AN EVALUATION FRAMEWORK

An evaluation framework should be established for the entire Technology Integration Plan. This serves as a template to assess the Plan's progress and provides evaluation guidance to the various action plans. A framework includes all outcomes and the qualitative/quantitative evidence (in general terms) considered valid in achieving those outcomes. We facilitate a work session with the Planning Committee to determine outcomes and indicators. The following framework provides an example:

Goal 1: Increased and improved access to educational opportunities and services for adult learners

Objective 1.1: To increase opportunities for adult learners to access a diversity of learner support services, course and programs within their community

Outcome 1.1.1: Strategies are developed to acquire necessary resources/telecommunications for 1997/98

Indicator: Institution has developed partnership agreements with various private-sector industries

Indicator: Regular discussions are held with telecommunications service providers

Indicator: Community resource group has been established to organize fund-raising activities

CONCLUSION

Implemented wisely, technology integration not only provides students and teachers with various technologies, it positions technology as integral to the teaching learning process. Technology integration means that technology becomes integral to how business is done in an institution. It becomes embedded in curriculum objectives and in student outcomes. It becomes part of the everyday practice of how teachers teach and students learn. Strategic planning for technology integration allows the technology integration plan to align and support institutional values and goals. Without a strategic fit, technology integration plans sit outside institutional "will" and fail to be enacted.

SToMP: A Dynamic Approach to Courseware Development.

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Abstract: SToMP (Software Teaching of Modular Physics) is a comprehensive software package designed for use in introductory level undergraduate physics. It provides the student with carefully written scripts augmented with activities, simulated experiments, references, glossary, historical material, and media clips which are displayed in an easy-to-use format exploiting the multi-windows computer environment. The material includes self- and assessed-tests for each module and an array of tools (calculator, spreadsheet, grapher etc.) which can be accessed from any point within the package. Two modules have been completed to date: Measurement and Uncertainty, and Waves and Vibrations. Other modules are in various stages of preparation.

This paper looks at the pedagogic rational for the SToMP system, and discusses modes of integration into existing courses. The system is dynamic, and is able to subsume new developments, some of which are described.

1 Introduction

Computers have been used in Physics for many years for many purposes, and attempts have been made for over twenty years to use them in the teaching of physics (e.g. Hinton 1977, Boardman et al 1988 and Wilson & Reddish 1992). During this time, however, no one method of using computers to enhance the teaching and learning of physics has emerged as a universal solution, and no two physics departments seem to use computers to aid teaching in the same way. This paper briefly discusses the problems of the introduction of IT-based teaching methods and why their use has remained marginal. It then introduces the Software Teaching of Modular Physics (SToMP) approach to meeting the needs of current problems in undergraduate physics teaching and learning. This approach has been developed by a consortium of academics within the Software Teaching of Modular Physics project. SToMP includes an efficient development environment, a consistent student interface and an integration mechanism that is widely applicable.

SToMP courseware takes advantage of all available computer-based media types and is inherently open to teacher and student. However, it has established guidelines and standards by which the media can be integrated in a structured manner and used to direct learning within prescribed curricula.

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2 The SToMP approach

Conventional science teaching usually involves the following student experiences,

- lectures and seminars, augmented in some cases by video and demonstration.
- tutorials and problem classes.
- laboratory work, often linked with practice in the presentation of information.
- individual problem solving and essay writing, often linked with assessment.
- project work, often linked with the use of information sources.

From a student's point of view these can often form a set of only vaguely linked aspects of the same subject. Topics within a physics course tend to be compartmentalised, and laboratory experiments are often badly out of step with the presentation of the appropriate theory in lectures. The use of an appropriate delivery mechanism for a topic, or the inclusion of a new student activity at an appropriate point, is hampered by the rigid structure of course modules imposed by timetabling, logistic or other constraints. These sorts of problems are particularly relevant to the introduction of computer-based materials into existing courses that are already tightly constrained by staff commitments and limitations in student contact hours. Also, many departments are experiencing difficulties in finding funds to equip laboratories for large first year courses and are turning to computer based simulations (dry labs). With the timetabling constraint thus removed, these 'experiments' can be integrated into the courses at their proper time.

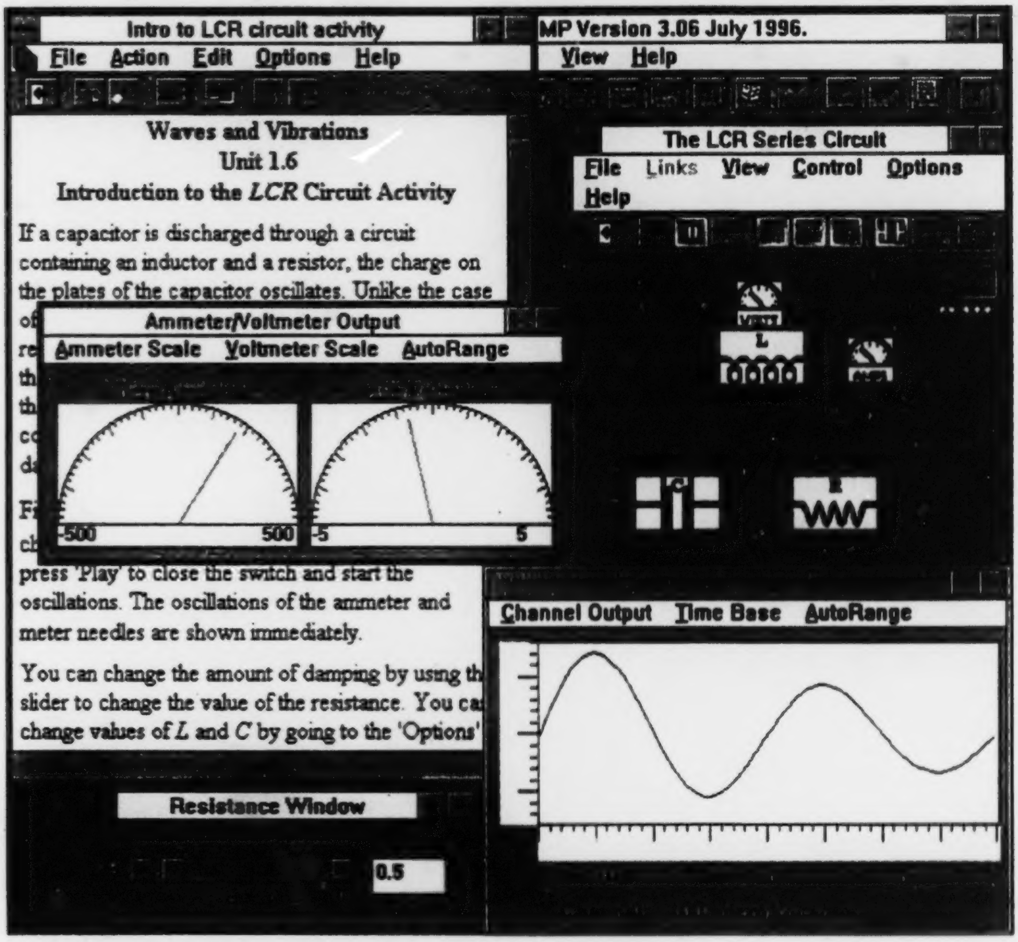
From the student's point of view, the introduction of a new computer based component to a course, in addition to existing activities, will not necessarily be taken seriously unless it is clearly an integral part of a course [Laurillard 1993]. This usually means that there has to be an obvious link with the course assessment.

The SToMP project has attempted to address these problems by providing a richly linked set of multimedia documents, interactive experiences and assessments that can be used as a replacement for some components of existing courses. The flexibility of the environment can also help improve the necessary conceptual linking between the disparate aspects of a course.

3 SToMP, a highly integrated system.

Each SToMP module comprises a complete and open learning environment that contains all the material needed for an in-depth study of areas of physics covered by that module. Two modules have been completed so far, Waves and Vibrations, Measurement and Uncertainty, and others such as Optics are under development. The completed modules contain over 100 hours of study material that can be used in place of conventional lectures as the principle teaching vehicle of a course. SToMP resources are best augmented by the usual tutorial support mechanisms and may be further enhanced by locally produced materials.

A SToMP module is logically structured into blocks which are further subdivided into units, each of which has a sparsely written but didactically complete teaching script. This leads the user through required subjects and arguments in the order required for suitable concept development. Modules are also provided with a rich resource of background material including sections from appropriate text books, video and audio sequences, pictures, animations, assessment material, a glossary, and other reference items such as data books and biographies. All the material is structured and indexed, and may be accessed via several information retrieval mechanisms. In addition there are a large number of interactive physical simulations and experiments that are introduced from the scripts together with documents describing how they can best be used [Fig. 1]. Students on a set course are expected to access the material by following these scripts. The layout of these provides consistent navigational cues to the importance of the linked material. The teaching strategy emphasises active involvement, with students being directed via questions through activities in a choreographed investigative manner. As part of this teaching strategy, scripts also contain problems which can require users to access other documents and resources in a more open-ended manner. The material included within each module is intended to be a superset of that which would be appropriate for any given course. This redundancy of material helps ensure flexibility of use, and is assisted by the built-in tutor's-notes files, which are designed to be edited by each course tutor.


Intro to LCR circuit activity
File Action Edit Options Help
MP Version 3.06 July 1996.
View Help
The LCR Series Circuit
File Links View Control Options Help
L
C
R
Ammeter/Voltmeter Output
Ammeter Scale Voltmeter Scale AutoRange
-500
500
-5
5
Channel Output Time Base AutoRange
Resistance Window
0.5

Waves and Vibrations
Unit 1.6
Introduction to the *LCR* Circuit Activity

If a capacitor is discharged through a circuit containing an inductor and a resistor, the charge on the plates of the capacitor oscillates. Unlike the case of

press 'Play' to close the switch and start the oscillations. The oscillations of the ammeter and meter needles are shown immediately.

You can change the amount of damping by using th slider to change the value of the resistance. You ca change values of *L* and *C* by going to the 'Options'

Figure 1: An interactive physical model of a series LCR circuit, with meters and oscilloscope, together with a descriptive introductory document.

In addition to the resources and activities described above, the SToMP environment also contains an integrated set of subject-specific tools that can be used in conjunction with other features for problem solving or for project work. These include calculators, a simple spreadsheet, a graphing package, a word processor, and a data conversion utility. Using these, the student is encouraged to see SToMP as a mechanism for 'doing' physics as well as learning about it.

4 Integrating SToMP into existing courses

The advantages of the 'complete environment' approach become clearer when the details of course integration are considered. The system can be used as a direct replacement for lectures and tutorials instead of creating a need for additional contact or laboratory time. The role of the teacher then changes from lecturer to mentor, so that there is more time for one-to-one or one-to-few discussions and explanations and less time need be spent on preparing the details of course presentation. The system uses a range of techniques to present theory and to relate

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it to the real world, and access to these resources is totally under the users control. This implicit tailoring to the needs of each student leads to self-paced progress that can match the learning style of each individual. The impersonality of the student's interaction with the computer may provide an additional advantage - students are sometimes hesitant about admitting ignorance to their tutor, but are less inhibited about accessing remedial help on a computer. It is important to emphasise that the material is open to students to add their own links, and to the tutor for adding both documents and links. At the simplest level, empty shell documents (tutor's notes) are included for the lecturer to provide study-guide advice to the institution's own students. At the other extreme, additional documents can be added incrementally and linked in to provide locally relevant emphases.

This integrated approach is a step beyond the piecemeal approaches often adopted in the guises of Computer Assisted Learning, Computer Based Learning, Information Technology in Education, etc. This system includes activities with relevant scripts containing descriptions and theory, problems and tests, and with appropriate background material being easily available. This creates the required environment for effective use of these resources that would otherwise need explicit definition by the teacher. The use of a standard user interface maximises the ease-of-use of the many components of the package, whilst the sophistication of a Windows based system supports the high degree of integration that the SToMP style requires. A multi-tasking environment encourages the use of a wide diversity of tools and on-line information sources within the learning activity.

5 SToMP use of windows

The windows user-interface is an important aspect of the SToMP learning environment. In a conventional (non-computing) learning situation, a student refers to several documents in one session, e.g. a text book, lecture notes, and the working of a problem, or, in the laboratory, the experimental equipment, the experiment instruction sheet, and a laboratory notebook. The windows interface implemented with a sufficiently high resolution monitor now supports this multiple document concept adequately, and such a multi-tasking interface is crucial to the effective use of the SToMP materials, which are designed to require several documents to be visible at the same time. For example, a test question may require a model to be used which in turn needs its own introductory text to be readable.

It is unfortunate that the early versions of the PC windows interface were available to the majority of users only on small, very low resolution monitors. This has had the detrimental effect of encouraging the 'misuse' of the interface by restricting applications to being run 'full screen', that is, to habitually take up the whole screen area with one application. It is only since the advent of higher resolution and larger size monitors that PC users are beginning to use their resources as effectively as UNIX windows users have since its inception.

An important factor for developers is the high quality and increased ease of use of the tools available for creating windows applications as compared to earlier DOS-based compilers. These not only enable quick and easy access to all the commonly required windows features but also support mixed language development by means of libraries of utilities or applications that are only linked at run-time (Dynamic Linked Libraries - DLL's). There is also a well defined and simple-to-use 'help' compiler, that allows for the speedy preparation of user support for each application.

Another factor that is contributing to the effective development of this style of integrated learning package is the emergence of standards for the presentation of the different media types within the windows environment. Despite the wide variety of hardware implementations of PC's, including the different sound cards and screen driver hardware, materials prepared to these standards perform in similar ways on different machines. In addition, and this is another important feature of the SToMP package, user institutions can prepare their own additional material of any media type, confident that it will integrate with the rest of the package in a seamless way. The

Microcosm™ Document Management System[1] used by the SToMP project allows such incremental additions to the linkbase to be achieved with minimal effort.

The windows style of interface is thus clearly an important enabling feature of the SToMP style of learning environment that requires users to access several related documents simultaneously. This use of windows can be much more than just the ability to have several documents open on-screen at one time. It can involve the copying of text, data, graphics, or other information from relevant sources into destination documents being prepared, for example, as private notes or as an assignment, or data into a spreadsheet for analysis.

6 Looking to the future.

The features that have been included in the SToMP materials to date are limited to those we have been able to either find or produce, that are of appropriate quality and style. The usefulness of this or any similar environment will be improved, in principal, if we can include additional features (e.g. more background reference material), more scientific tools (e.g. an integrated algebraic manipulator such as MAPLE), further experiment simulations, or the additional modules required to provide a complete coverage of the first year syllabus. The usefulness of this style of environment will also be improved if the necessary computing skills to use it were acquired by students before reaching higher education. The lack of these skills seems inappropriate given the almost universal use of computers throughout all information based employment. We suggest that computer skills (touch typing and common interface usage) should be added to the basic skills that are a core part of secondary education. This would make a significant impact on the efficiency of use of computers in higher education, and on the accessibility of integrated packages such as SToMP.

One of the most important developments of SToMP is currently the extension of the integrated assessment mechanism. SToMP modules include not only self-evaluation questions within scripts (a useful didactic device that has been increasingly adopted in text books in recent years) and investigations which require the student to use the SToMP tools to answer questions related to the relevant module, but also automated tests with the question styles ranging from simple multiple-choice identification, through pair-matching from lists, to problems requiring a numeric input. In the self-test mode these tests are important as a means for student's self-evaluation and are particularly appropriate in a self-paced learning environment. In assessed mode they are an obvious means by which teaching efficiency can be improved without sacrificing quality and, if summative even at nominal levels, would motivate the students to use the material thoroughly. We are currently increasing the number and quality of both self and assessed tests within the SToMP materials, and we are also improving the security of the system for assessed tests.

It is interesting here to note the heavy use made by mass education institutions (e.g. The Open University, UK.) of machine-based continuous and examination assessment. The economics of such methods are compelling when student numbers are high, as they must be when the course presentation mechanisms are expensive and capital intensive (as they are in projects such as SToMP).

With the emergence of 'complete courses' available via a computer as described here, the issue of access to machines by students is another factor of significance. Different institutions are adopting different strategies to achieve this end, from 'giving' a computer to each student (as at Brighton University UK), requiring that newly entering students have one (as at Acadia University in New Brunswick), through to providing 24 hour access clusters. Whilst the actual mechanism is not too important, it is obvious that there is a closed loop in which the investment has to be justified by use, which in turn leads to more investment, until the ratio of machines to students reaches 1:1. This would still not solve all the problems, however, because of the two apparently conflicting requirements - that students can work at home with their computers, and also are able to work in supervised laboratories.

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[1] Microcosm is a registered trade mark of Multicosm Ltd., Southampton, England. http://www.multicosm.com/

There is a distinct convergence between the approach we are adopting within the scope of the SToMP packages and the rich linking that is now implicit in, for example, World Wide Web or Hyper-G [Andrews et al 1995]. We might speculate on the opportunity of augmenting a local learning environment (with sets of documents and links) with a more comprehensive set of documents. This could enrich the overall range of learning experiences without necessarily introducing significant time penalties or diluting local autonomy.

Looking a little further into the future, the use of artificial intelligence to improve the learning experiences of users of packages such as SToMP will conceivably challenge the quality of teaching obtained at Universities that use individual student tutoring. In a lecture, the pace of presentation is controlled predominantly by the lecturer who is unable to cater for all requirements. As the ratio of staff to student improves, the matching of presentation rate to acceptance rate improves, but only as the ability range of the group narrows. One student with a skilled tutor will learn at the optimum rate because the tutor will match presentation and discussion to the perceived rate of concept development, often attempting to 'stretch' the student. The current style of SToMP provides material at the rate demanded by the student, but does not provide much incentive for an able student to go beyond the stated minimum requirements. An artificially intelligent (and highly interactive) system would be able to match a student's requirements in a way that maximised their individual learning potential.

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Improving Spanish Phonetics Instruction with a Hypermedia-assisted Application

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Abstract: This paper describes the design and development of the prototype of a hypermedia application to enhance Spanish phonetics instruction for American and Hispanic students. In addition to meeting the various objectives of a phonetics course, the current application remedies the inadequacy of current Spanish phonetics methodology and fulfills the various needs of a dynamic and diverse student population taking Spanish phonetics at the college level. Traditionally, Spanish phonetics learning is supported by textbook and audio cassettes alone. This methodology is not efficient enough in providing a learning environment that encourages students to develop an introspective awareness of speech. In this paper, we will show how we improve Spanish phonetics instruction by integrating various powerful features of advanced authoring systems into the application.

1. Background

"Phonetics is the systematic study of human speech-sounds. It provides means of describing and classifying virtually all the sounds that can be produced by human vocal tracts" [Catford 1988]. Having a basic knowledge of phonetics is indispensable to any person who works with language. The teacher of languages needs the theoretical and practical knowledge of phonetics to diagnose the pronunciation errors made by students and to devise the means of correcting them. Students of languages also need the same knowledge to help them self-monitor their pronunciation.

The Spanish phonetics course is set up to meet the following goals. It aims to 1) assist in improving students' pronunciation through self-monitoring and recognition of common problems demonstrated by American-English speakers, 2) help students associate the sounds of the language with spelling, 3) expand their knowledge of the various dialects of the language, and 4) introduce them to the field of phonetic and phonological analysis.

Although it is possible to gain a good theoretical knowledge of phonetics through reading, it is the ability to capture the differences between various sounds through listening and manipulating articulators in the vocal tract that establishes the foundation of a deep understanding of the subject. Traditionally, students taking Spanish phonetics are rarely taught to contrast sounds through listening or consciously controlling their articulators. A phonetics class emphasizes on the discussion of the sound system more than gaining practical knowledge about it. Students are often left to imagine what a sound is like. They do it either by notes from the lectures or explanations in the textbook. Sometimes they associate the sound with a sound that they are familiar with. Audio cassettes have been a major device used in the classroom to demonstrate sounds, and they have also been available to students for outside the classroom. But, due to the limited capacity of the cassette player, it is difficult to locate a specific item without rewinding cassettes back and forth many times. The result can be frustrating and time-consuming. Moreover, it creates an unpleasant interruption to the learning flow. Consequently, the demonstration of sounds through a cassette player is usually conducted at once at the end of a lecture. It usually covers a long list of items and several exercises of various purposes. This strategy generally does not produce a good result. An alternative approach such as live demonstrations has also been adopted by instructors. However, bringing informants to the classroom is not always feasible since finding them and scheduling their visits are difficult tasks. Besides they are no longer accessible to students after the class.

In many cases a crucial difference between two sounds may be too subtle to be detected by the ear of a speaker of a certain sound system. Under such a circumstance, repetitions are undoubtedly mandatory. The students taking Spanish phonetics at the college level have very different backgrounds. There are both native speakers and non-native speakers. There are also beginning graduate students and upper-division undergraduate students. In accordance with their background, their strength on sound distinction and their paces on sound capturing can vary. For instance, when certain English allophonic variations seem to be indistinguishable to native speakers of English, they are distinct to native speakers of Spanish and vice versa. A psychological factor also needs to be taken into account when conducting listening or pronunciation exercises in the classroom. Some students would feel embarrassed if they made mistakes or if they were slower in a classroom setting. On the other hand, while native speakers of Spanish do not have the need to improve their pronunciation of Spanish, non-native speakers do. Furthermore, due to the complexity of articulatory movement, many students have difficulty grasping a concept by reading the textbook alone. This is true even when the language barrier is not a contributing factor.

Due to the lack of adequate and efficient tools to address the various needs, training beyond intellectual comprehension of Spanish phonetics has not been given enough attention. This situation calls for a solution.

2. Program Overview

2.1. Content

The phoneme /s/ is selected to demonstrate the design of the prototype of this application [Fig. 1]. The corresponding orthography rules are chosen to be in the first lesson because they are the basis of Spanish phonetics. Before starting a lesson on a phoneme it is important that students, both native and non-native speakers, have an understanding of the relationship of spelling to the spoken language. Contrary to English, this relationship is almost entirely regular in Spanish.

One of the objectives of the articulation lesson is to provide a very concise explanation of articulation for every allophone of a phoneme. Another objective is to help users visualize the physical process of articulation through animations describing and simulating the movement of articulators synchronized with narration and sound. It aims to help students who have difficulty visualizing the articulation process through ordinary textual explanations. It also encourages them to explore and experiment with their own articulators at the stage of trial and error in a private setting. When used by instructors, it can also be a teaching aid. This prototype program has covered the variations of the pronunciation of the phoneme /s/ (predorsal /s/, /s/ aspiration, /s/ deletion, and apical /s/, etc.).

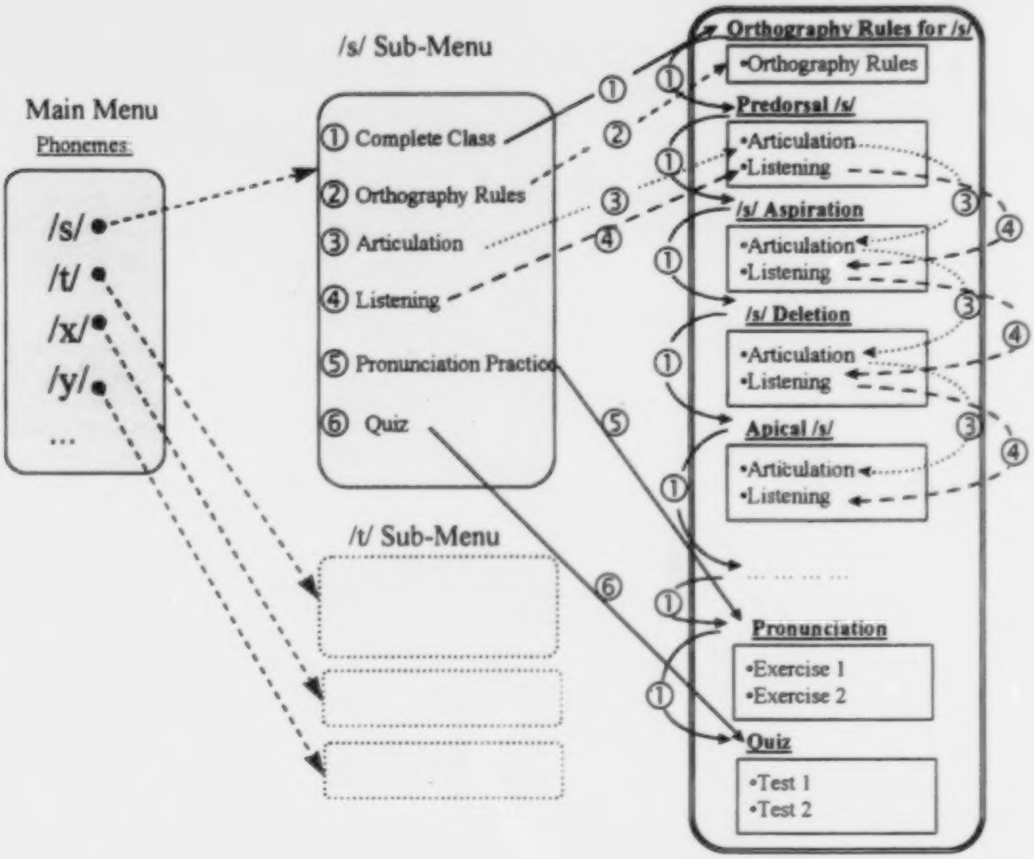
Main Menu
Phonemes:
/s/
/t/
/x/
/y/
...
/s/ Sub-Menu
① Complete Class
② Orthography Rules
③ Articulation
④ Listening
⑤ Pronunciation Practice
⑥ Quiz
/t/ Sub-Menu
①
②
③
④
⑤
⑥
Orthography Rules for /s/
•Orthography Rules
Predorsal /s/
•Articulation
•Listening
/s/ Aspiration
•Articulation
•Listening
/s/ Deletion
•Articulation
•Listening
Apical /s/
•Articulation
•Listening
... ...
Pronunciation
•Exercise 1
•Exercise 2
Quiz
•Test 1
•Test 2

Figure 1: Program Structure and Path

For each variation of the pronunciation of the phoneme /s/ there is a corresponding lesson on listening practice. It substitutes the function of audio tapes to provide samples of dialectal pronunciation in various phonological contexts. Using this, to repeat an item only requires a click of the mouse. It also makes comparing and contrasting sounds faster and easier as students can easily jump from one point in the program to another. In many cases same sets of words or sentences are chosen as examples so that users can easily compare different dialectal variations of pronunciation by contrasting them. It also offers an easy recording and play-back device to allow users to compare their pronunciation with a native speaker's pronunciation.

The lesson on pronunciation points out pronunciation problems commonly committed by American students and also provides model pronunciations. In addition, it offers an easy recording and play-back device to allow users to compare their pronunciation with the model. In this prototype two exercises are included focusing on correcting the use of erroneous pronunciation [z] for the letter z and for the letter s within words that have English cognates.

The Quiz gives students an opportunity to check their comprehension of the material covered in the whole course under one phoneme. It consists of three sub-tests. The first test serves as a pre-test that evaluates intellectual comprehension of the subject. The questions are either textual or concern the movement of articulators demonstrated by animation. Users will be advised to pass the first test before going on to the subsequent tests. The second test is a listening test on sound distinction at the word level. The third test evaluates the sound distinction ability at the sentence level. Both tests allow users to hear the words or sentences being tested as many times as they wish. Every time users enter the second or the third test, the program will randomly select one question out of five from each question bank. The questions are carefully formulated so that no obvious patterns are detected. That prevents students from guessing through the tests.

2.2. Semantic Structure

To help students accomplish their particular objectives, the program offers six different pathes under a phoneme and each has a course title reflecting its function: Complete Course, Orthography Rules, Articulation, Listening, Pronunciation Practice, and Quiz. Each course can be accessed individually. Therefore, students who only want to go over the listening exercises on /s/, do not have to go through every lesson in the program. Hence, each user can target his/her personal objective and choose a path to follow based on his/her own pace. The instructor may also concentrate on an individual student's need and assign a corresponding task through a path.

The Complete Course is a path allowing access to all the materials covered under one phoneme. It targets users who wish to preview, review, or reinforce the learning of Spanish phonetics in an individualized way. Although it follows a predefined path, the user has the freedom to move from any point in the system to any other s/he wishes. This is accomplished through either the default navigation features of each screen or the hot links on the detailed sub-menu, both of which will be explained in detail later in the section on navigation. Research has shown that users are less likely to feel disoriented or lost when there is a predefined path that narrows their options for navigation [Zellweger 1989]. Thus the path is predetermined from the instructor's perspective on how lessons can be best learned.

2.3 Navigation

From top to bottom, the program contains two menu screens. When a user enters the program, the first menu s/he encounters is the main menu, from where s/he will select a phoneme. In this prototype only one phoneme (/s/) is available for access [Fig. 1]. Subsequently a sub-menu screen appears, which contains a list of six radio buttons corresponding to the six pathes (or six courses) [Fig. 1]. As soon as the user clicks on one of the path units from the list, a detailed sub-menu containing a list of the corresponding lesson screens will appear at the right side of the current screen. The user can either click on the start button to start the lesson screens contained within the selected path (course) in a linear way or s/he can click directly on the lesson screen that s/he is interested in from the detailed sub-menu. This makes each lesson screen within a path accessible individually. This means that if a user has to abort the program in the middle of a course, s/he can restart right from the point where s/he left off.

Under the articulation path, a projector icon is displayed on certain screens to suggest that those screens contain animation on articulation. This enables instructors to locate them easily for classroom demonstration.

Within each path (course), using the default navigation feature of the authoring software, the user can follow a course both forward and backward one screen at a time, backward to the very first, or forward to the last screen. S/he can also open up a list of the screens being accessed and jump right into any one of them. In addition, s/he can leave the course and go right back to the sub-menu or use search function to locate a specific screen.

3. Program Features

3.1. Narration

Narration is used in the program whenever applicable since it takes less effort to listen than to read a text. However, it is used in congruence with visual display to facilitate the processing of information [Hoogeveen 1995]. For instance, a flying graphic, which is in textual format, corresponding to the point in narration, will appear on the screen to enhance the learning effect. On the other hand, the transcript of narration is available through selecting the show button.

3.2. Animated Texts Synchronized with Narration

As mentioned in the previous section, one of the multimedia features we include in this program is the synchronization of animated texts and narration to simulate a live lecture. This feature is used when simple texts are needed to exemplify points in the lecture.

3.3. Animated Graphics

Graphics showing the side-view of vocal tract have been widely used by phonetic books for pedagogical purposes. In our program, graphics of this nature are also adopted but added with other features. We use animated arrows as well as animated colored shapes on articulators to clarify and emphasize points in the lecture. In addition, to simulate the process of articulation we have used animated graphics along with concurrent pronunciation. It is suggested by Johansson that our visual system is developed to handle continuously changing information rather than static pictures [Hoogeveen 1995]. This favors the inclusion of time-based data, such as motion pictures. It is also shown that student's oral production would benefit from the simultaneous decoding of auditory data and sagittal representations [Lilly 1995]. Animated graphics and digitized sounds are thus chosen in this program. They will show how the mouth or articulators interact and shape up on affecting the air stream to be stopped or released through the mouth or nose along with the movement of vocal cords. Recent technologies allowing the exact synchronization of sound and animated graphics offer the possibility of demonstrating a supposedly simultaneous activity among vocal cords, articulators, and the flow of air, thus providing more realistic images of the articulatory process. Since a more realistic representation of information seems to lead to more natural arousal [Hoogeveen 1995], such simulated oral production, which is closer to real-life experience, may stimulate student's interest in experimenting the production of sound.

3.4. Hypertext

The transcripts of narration is hypertext-enabled. When the user clicks on a linked-text, a pop-up glossary explaining the terminology will appear. The text window closes when the user clicks anywhere on the screen.

4. Lessons Learned

4.1. The Selection of Software

Like all the other multimedia projects, the first question we faced was which software tools should we use for the project? Naturally, the search started from going through different authoring tools. The requirement for the tool is that it is easy enough for a non-programmer to use. Yet, it is powerful enough to allow all our program features to be developed. Quickly, we eliminated Visual Basic and Powerbuilder which require a lot of programming skills and are not fully integrated with some multimedia elements such as animation and video. After doing some research, Macromedia Authorware came to the top of the choice. Authorware provides a very simple interface to allow developers to create programs by drawing flow charts. It is easy and powerful for most of the cases. However, in the cases that require complex logic, some programming experience is required. Another reason that we selected Authorware is its' seamless integration with Macromedia Director. Director is a tool favored by a lot of animation and video developers. The integration of Authorware and Director eliminate the long existing limitation between authoring tools and video clips. For most of the authoring tools, the video clip is a separate entity. No communication can occur between the authoring program and the video clip except the basic play and rewind actions. Authorware and Director break this limitation by allowing Authorware to pass certain events (mouse click or key press) to Director. It opens up great freedom for application developers to design their products. Another reason that we have selected

Macromedia Director was because of its easy control over the exact synchronization of sound and animated graphics.

The greatest challenge for most in-house multimedia developers is the graphics. Most developers are not artists. How can we design a beautiful screen with the absence of the artist? CorelDraw and Macromedia xReses are the life savers of this project. CorelDraw is a comprehensive drawing tool. One of its' components is CorelTrace, which retraces the outline of the scanned in bitmaps and allows modification of the traced outline. xRes is an image painting and editing tool. Combing both tools, all the pictures in the magazines or books can be easily digitized and converted to the desired images.

Compared to the other multimedia elements, sound is the easiest element to control. Sonic Foundry's Sound Forge was used to edit sound files and to eliminate the noises created during the recording process.

4.2. Original Interface Design

User interface design is usually under the constraint of the software capability. For example, the original design of this project was to make use of a tree-like interface such as the Microsoft explorer in order to provide easy access to each lesson screen and to show an updated indication of the lessons being accessed. This type of interface structure is more exhaustive and the user does not need any provisional jumps in order to decide which further step to take. Unfortunately Authorware does not provide an easy mode of implementation. We therefore redesigned the interface in such a way that navigation efficiency is still maintained.

5. Summary

Spanish phonetics class plays an important role in helping students acquire needed knowledge and skills in differentiating sounds and in correcting pronunciation errors. The new computer hypermedia technology has made it possible for educators to develop appropriate application programs to fulfill students' needs as well as to correct the inadequacy of traditional teaching methodology. This paper has discussed the relevant issues of Spanish phonetics instruction and has described an effort to enhance the traditional teaching methodology. That effort has been made by developing a hypermedia-assisted application that takes advantage of the powerful features of current authoring systems. The development of such project suggests that the current technology may be properly used to meet the instructional needs for certain subject areas. Similar projects are thus welcome and the educators should be encouraged to develop their own applications.

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Video E-mail: Hybridising Two Technologies Offers the Best of Both Worlds

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Abstract: A pilot implementation of the concept of video e-mail is described. The purpose for which the system under development is intended is the provision of prompt assignment feedback to students studying visual art through open learning. The system being developed employs a combination of high speed digitisation, video compression; and MIME encoding to transmit digital video over convention e-mail networks. This paper describes the design principles employed, the developmental approach and the progress that has been achieved on the project so far.

Introduction

Many distance educators have been excited by the possibility which has been offered by the recent rapid advances in digital video technologies of using desktop video conferencing for the delivery of distance education programs to students in their homes. However, what many distance educators do not realise is that the data stream required to support high quality full-motion video is much larger than most telecommunications links can carry.

The digitisation of video generates data at an amazing rate. As an indication, digitising a full-frame, full-speed, full-colour video generates about 100 Mb per minute of data. When capturing to disc, as occurs in the creation of multimedia productions, such large volumes of data quickly fill the capacities of data storage media. In a communications environment, this flow exceeds the capacity of all but the most expensive data communication pathways. One way in which these capacity limitations are ameliorated is through the use of digital compression.

Video compression is now being used extensively for the inclusion of video segments on CD-ROMs. It is also starting to be used for inclusion of video clips in World Wide Web databases. However, the concept of video compression was first developed to support low bandwidth video conferencing. Video compression technology has therefore been evolving for more than a decade. Notwithstanding this, even the best available technology is still insufficient to support good quality full motion desktop video over telephone lines. It is still not practicable, therefore, to offer video conferencing amongst students in their homes.

By comparison with digital video, electronic mail is a mature technology. Electronic mail has been used in distance education as a routine means of communication between teachers and students by some institutions for more than a decade. This technology has been found to be both reliable and functional. Furthermore, despite its comparative simplicity, e-mail technology offers some advantages compared with video conferencing for distance education support. It is an asynchronous form of communication and therefore does not require teacher and student to be available at the same time. It can be carried over low data rate links and therefore can serve a more dispersed student population. It is economical to establish, maintain and use and therefore can be made available at much lower cost.

The difference between what can be accomplished within a desktop computer and what can be accomplished over a network reflects a generational gap between the relative stages of development of computer compared with data communications technology. Data can be moved around within a computer must faster than it can be moved from one computer and another. Furthermore, data can generally be transmitted much more easily within a local area network than within a wide area network. This generational gap will take time to close. However, in the meantime, there is the potential for creating some new and interesting possibilities by hybridising technologies. Combining digital video and e-mail technologies represents one such hybrid.

However, most people regard the concept of sending video over e-mail as being technically impractical even though standards exist for this type of transmission. However, what limits the value of the concept is the relatively small amounts of video that it is possible to send at a time.

At the Royal Melbourne Institute of Technology work is currently underway to investigate the practicability of combining video and e-mail technologies to support courses offered by distance education. The particular application which is forming the context for the investigation is the provision of feedback on student assignments in fine art. This work is being supported by a grant from the Open Learning Agency which is the brokering organisation responsible for Australia's open learning program.

Implementation of a full video e-mail system implies that users of the system are given the ability to generate and transmit video messages. This is problematic at the present time because the capture of video requires specialised hardware and processing capacity which is not available from typical computers found in the home. In the particular application chosen for this pilot project one-way video is acceptable. The use of a one-way transmission has the further advantage that the limitations of 'receiver' work stations to be compensated for by the greater power of the 'transmitting' work station. The project which is about to be described employs this approach.

Outline of the basic concept

Producing compressed digital video recordings is often quite tedious and time consuming. Adapting the standard approach to the production of video e-mail would make the concept unworkable. For the concept to be practical it needs to be simplified. Two ways of simplifying the process are to standardise the capture variables and to automate the capture/transmission sequence. In the case of the target application variables such as lighting and exposure can be standardised by using a constant field of view. Automation of the process can be achieved by bringing all the basic functions under the control of a small applications package running on the computer. The applications package can also manage a database of students' names indicating whether or not each student had the capacity to receive e-mail messages and if so, what the student's e-mail address is. If the student possessed an e-mail address, then the control application would create a standard e-mail message, add the video file as an attachment, and dispatch the message to the address. If the student didn't have an e-mail address then the control package would send the video directly to tape.

The concept of video e-mail involves four distinct processes: video capture, video compression, e-mail encapsulation, and video replay. Each of these processes requires its own specialised hardware and/or software. For the concept of video e-mail to be workable, all of these processes must be able to function together. However, to understand how integration of the functions can be achieved, it is necessary to understand how they function individually.

Video capture

Video capture hardware and software has been available for desktop computers ever since the advent of interactive multimedia. Initially, video capture was achieved through the addition of plug-in boards. However, as the popularity of multimedia increased has grown, a number of mid and high range desktop systems have appeared on the market which provide all the features needed for capture of video images and sound. The quality of the resulting images and sound does depend to some extent on the capabilities of the individual system. However, it is possible to obtain quite good quality sound in machines of quite modest cost.

Video compression

The device used to compress digital video is known as a 'codec' (compressor decompressor). Video compression can be accomplished either in hardware or in software. Hardware codecs compress and decompress at a faster rate than software codec. However, video which has been compressed with a hardware codec generally, although not always, also requires a hardware codec for decompression. For the type of application being considered here, it is necessary to use a software codec for decompression. To use a hardware codec would require that every student acquire a suitable codec as such codecs are not incorporated into most current generation systems.

Software codecs differ greatly in the degree of compression they offer. There is a trade-off between the degree of compression offered and the quality of the resulting image — as a generalisation one can expect that the greater the compression, the poorer the image.

Software codecs are installed at the operating system level. Apple provides several codecs with the Quicktime extension which is included with every Macintosh sold today. However, the best compression ratios can currently be obtained with codecs based on fractal technology and such codecs are at the present time sold separately.

E-mail encapsulation

E-mail systems were originally developed to transmit text-only messages. With the development of multimedia, methods, of transmitting other types of information were needed. In recent times a new protocol has been developed to handle multi-part documents [see Rose 1993]. This is called MIME. MIME includes a specification for transmitting video attachments. Users of the World Wide Web rely on MIME every day — it is incorporated into the helper applications which confer on Web browsers much of their functionality. MIME specifies the way information should be encoded and also ensures that it is handled appropriatly in The appropriate approach to transmitting video as an e-mail attachment is therefore to use a MIME compliant e-mail client.

Video replay

For it to be practical to use video in off-campus teaching students must be able to view video files when they arrive. Fortunately, with today's computers this is not such a problem provided that one is prepared to compromise on quality. Macintosh computers now come equipped with everything needed to replay a Quicktime movie. The software needed to replay a Quicktime movie on a Windows system can also be downloaded from Apple's Web site. However, playing movies on a PC does require the availability of a sound card such as the Soundblaster card. While these are now being to support games, they are by no means universal.

Students can't, of course, all be assumed to have the same type of computer and unless an institution decides to prescribe what computer a student must have in order to study a subject provision must be made to support a range of systems. The reality is that the Macintosh provides a more robust development environment for multimedia. Furthermore, the Macintosh has, at least in Australia, a strong following in education. What this implies is a need to support both Macintosh and Windows users. In this project, the need to operate in a cross-platform environment was taken as a 'given'.

Supporting cross platform is not as difficult as might at first be imagined. Current generation Macintoshes come fully equipped to play Quicktime movies right out of the box, and the software that gives them this capability — the Quicktime extension and Movieplayer application can be installed on all machines running System 7.0 or later. In trials conducted in the course of this project, satisfactory performance was obtained on an six year old Macintosh LC II.

Proving the concept

Recognising the critical dependency of the project on the capacity to compress the captured video sufficiently that it could pass through an e-mail system, it was decided that some initial investigations should be made of the performance we could expect to achieve.

Initial estimates indicated that it would be optimistic to expect to be able to capture and transmit more than two minutes of video at a time. Theoretical calculations based on typical compression ratios suggested that 2 minutes of video ought to be able to be compressed to under 5 Mb. This is still a very large file to try to send via e-mail. On the other hand, it seemed that a video that was much shorter than that would be likely to be of little educational value. How useful a two minute video clip would be was also open to question. It was therefore decided to perform some tests to ascertain whether the information that assignment markers considered important to communicate could be captured within the target two minute limit.

The tests were conducted by timing the recording of what was considered by the assignment markers to be the appropriate amount of feedback and then looking for ways in which the recording could be brought back within the target limit. The first attempt to record feedback took about four and a half minutes. However, with practice the recording time was able to be brought within the two minute limit. These tests showed that it was possible to capture a surprising amount of information in a two minute period provided that one was adequately prepared and the material that was being recorded could be laid out beforehand. If these conditions were not satisfied, it might take two to three times as long to capture the same amount of information.

Selecting a platform and development environment

Because of the rapid developments that are occurring in the technologies associated with multimedia, it was considered that the most appropriate approach to take to designing the system would be to base the design on a series of building blocks. By breaking the design of the proposed system down into its major components, and then loosely interfacing these components through computer control, each of the components can be optimised for the function it is meant to perform. The system as a whole can then be upgraded by replacing individual components as technology advances.

Evaluation of the alternative hardware options indicated that it would be simpler to construct a system based on a Macintosh than a Windows platform. The tighter integration, the better built-in capabilities for video and the greater inherent reliability of Macintoshes make these machines much more suitable platforms for development of a system which cannot afford to make heavy demands on technical support.

Having determined that the best choice of platform for developing a video capture system would be a Macintosh (or Macintosh clone) it was a relatively simple choice as to which model to select. At the time when the choice needed to be made only two Macintosh models offered the power and features that were needed. These were the 8500 and 9500 models. However, while the 9500 offered greater processing power, the 8500 provided video-out and well and video-in capability. This feature is needed if captured video is to be recorded to tape.

Locating a suitable video camera initially presented some difficulties. The type of video camera which is now found in the consumer electronics market is a complete camera-recorder system. However, despite the high degree of sophistication of these units, few provide any facilities for external control and none appear to provide the ability to control the recording functions. However, what was needed here was a small good quality camera and separate recording unit which could be independently controlled. The consumer electronics market does not offer such products. Eventually a suitable camera was found in the form of an industrial camera manufactured by Panasonic. An industrial video recorder manufactured by Panasonic was also chosen for capturing the video on tape. This recorder has an RS-232C interface for enabling all the mechanical functions to be controlled by computer.

In the past, the type of system integration being sought here would have required the development of a piece of dedicated software in a high level language such as C, C++, or Pascal. This would have necessitated the investment of a substantial amount of a programmer's time. Today, an alternative option is available — the integration of existing applications by means of scripting.

Scripting has been possible on the Macintosh since the release of the first version of Hypercard. Hypercard's scripting language of Hypercard is Hypertalk [Winkler Kamins and Devoto 1994]. With this scripting language it is possible to develop quite advanced Hypercard-based applications packages. However, Hypertalk is not the only scripting system for the Macintosh. More recently, Apple has developed Applescript as a general scripting language. Many applications for the Macintosh now support Applescript scripting capability. Apple subsequently extended the concept of scripting with the introduction of Apple Events — a message that can be sent to an application to tell it to do something [Trinco 1995]. From Version 2.2 onwards, Hypercard has supported Applescript as well as Hypertalk. Hypercard therefore has the capability of both to act both as a system integration tool as well as a user interface construction tool.

Scripting can also be accomplished in a number of other ways. Scripts can be attached directly to Hypercard objects such as buttons and check boxes. Using this approach, the user interface would be designed in Hypercard and Hypercard may also be used to provide other functions. Scripts can also be written and debugged in Script Editor, a scripting tool which is now supplied with every new Macintosh. Script Editor can be used to create standalone script applications but these lack an interface. To provide an interface another interface design tool is needed. Apple has been supplying the third-party package, Facespan, for this purpose. A third option is to use the Frontier scripting environment. Frontier was one of the first application development environments to take advantage of Apple Events. Frontier has its own scripting system which employs a hierarchical command structure. However, Frontier can also call Applescripts. Frontier has a user interface design tool called MacBird as well as a faceless relational database. However, Frontier's sophistication is a disadvantage as well as an advantage for it demands considerable skill on the part of the user.

In this project, it was decided to use Hypercard as the developmental environment. There were several reasons for this. Applications that are programmed in Hypercard can easily be modified easily. Hypercard therefore offers a very suitable environment in which to develop prototypes. Second, Hypercard player is standard with every Macintosh and therefore Hypercard applications can readily be moved between machines. Third, Hypercard offers quite sophisticated database capabilities which may be used in this project to generate a database of students' details. Lastly, and perhaps most importantly, Hypercard is presently being updated to a multimedia authoring environment making it even more suitable for the type of application being developed here.

Developing the prototype system

At the time of writing, the project has reached the stage of integration of the major components of the capture system.

Choosing a Macintosh platform simplified the task of physically connecting the various components. The Macintosh's support for the S-Video standard allows S-Video cabling to be used throughout minimising losses in quality of the video signal during transfers. The major task in bringing together the various components therefore involves the development of the control software.

The first task to be tackled was control of the video recorder. This was chosen because it was perceived to be the design goal that would be most difficult to attain. The recorder is designed to interface with a DOS/WINDOWS computer and differences between communication standards between the DOS/WINDOWS and Macintosh environments were expected to give rise to problems. Indeed, this was found to be the case. Problems were encountered with both the hardware and software. The hardware problems were solved by treating the recorder as though it were a modem. The software problems proved to be more difficult.

Hypercard lacks the capability of controlling the modem port directly. To communicate with the modem port from Hypercard therefore requires additional software. The first approach that was used was to add Apple's System Tools extension to the system and an XCMD called CommConnect to Hypercard. This provided the communications link that was needed. However, all attempts to transmit commands from Hypercard to the recorder failed. An alternative approach was therefore tried. This was to use an Applescript applet. This worked flawlessly.

Mailing of messages will be accomplished by using Eudora. Eudora is highly scriptable and all functions of the package that will be required for this project, including compilation of the text message and attachment of the video clip, will be able to be controlled from Hypercard.

Development of the student database is being undertaken in Hypercard itself. Student information will be stored in a Hypercard stack and individual student's details will be accessed by selecting from a scrolling list. Selecting a student's name will indicate to the system whether or not the student has e-mail access and, if so, the student's current e-mail address.

Contrary to initial expectations, the most difficult aspect of the project is turning out to be controlling the process of video capture. While Apple has developed an XCMD for replaying Quicktime movies, no-one appears to have developed an XCMD for capturing movies. The approach that is being used is therefore once again to use scripting to control another application. However, few capture packages offer scripting control. FusionRecorder, which is no longer a current product, offers some scripting capability and it is hoped that this will prove suitable.

Limitations of the prototype system

The most important limitations of the prototype system relate to data handling. As has been explained, the capacity constraints of e-mail hosts feeds through to other aspects of the system's design and places tight constraints on the best that can be achieved at the present time. In the prototype, every avenue of reducing the amount of data that is generated is resorted to — the frame size, frame rate, the number of colours in which the image is captured and the duration of the video clip are reduced to a minimum. This has an obvious effect on the quality of the resulting image. Obtaining an improvement in the quality of the image therefore depends on improvements in technology. However, it is safe to assume that such improvements will be forthcoming.

The choice of Hypercard as the development environment may be considered by some to impose limitations on the speed of operation of the system. However, the penalty here is slight and the advantages that Hypercard offers far outweigh the disadvantages.

The fact that the prototype will only be able to support one-way transmission of video is a major limitation of this implementation of the video e-mail concept. However, it is not such a major limitation in the context in which the pilot is being developed. Again, improvements in technology will overcome this limitation.

Possible future developments

In describing the way in which we have managed to combine a variety of technologies, I would not like to leave the impression that the system we are developing promises to put video e-mail in the hands of every distance educator. The system is very much experimental. It has many shortcomings in its present form, not the least of which is the quality of the images we can transmit. It is in fact a testbed for trialling the concept. However, all the factors that we have identified as limiting the performance of the system are likely to become less problematic as technology improves. The value of the project to us has been the opportunity it has given us to get to grips with the many complexities of video capture, video compression, mailing of non-text attachments, and scripting. This knowledge can now be extended to a number of other applications.

Although the way in which we have assembled the components of the system is specifically designed to support video e-mail, the general approach being used in this project can readily be adapted to use in conjunction with a bulletin board. In this case, video clips would be posted to the bulletin board rather than being e-mailed directly to the student. This approach would be particularly applicable to bulletin boards maintained on the World Wide Web. Posting video clips on bulletin boards could offer educational advantages in many situations because this would enable students' work to be made available to other students to view. This is a concept which we intend to develop alongside the video e-mail system.

Conclusion

The project that has been described in this presentation has both technological and educational components. The early phase of the project has, of necessity, had to be focussed more on technological than on educational issues. To someone who is more concerned with educational issues, the problems that have had to be tackled may seem too technical to be of interest to educational specialists. Yet it is the way technical problems such as those that have been encountered here are tackled that determines the range of possibilities that we have available to us in education. Perhaps the greatest lesson that has been learnt from this project so far is that the lessons learnt from this project are likely to be applied in a variety of directions. That, surely, is what innovation is all about.

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Three Important Research Agendas for Educational Multimedia: Learning, Children, and Gender

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Abstract: This paper discusses three often-overlooked characteristics of educational multimedia systems that are important for human-computer interaction (HCI) researchers: (a) learning environments have very different goals and approaches than do workplace environments, so HCI research must investigate issues within the context of learning; (b) what works for adults will not necessarily work for children, so HCI research must develop usability guidelines that are appropriate for children; (c) girls and boys interact differently with technology, so HCI research must understand how each gender interacts with computers. We illustrate each of these issues with examples from our own research and explain how the characteristics of educational multimedia systems can lead to computing environments that do not hinder children's learning and do not exclude any children on the basis of gender.

Keywords: Human-Computer Interaction (HCI), children, learning, education, gender, educational multimedia, interaction styles, games, collaboration

Introduction

Human-Computer Interaction (HCI) research has primarily been concerned with adult users in the workplace. When investigating HCI issues for the design of educational multimedia for children, it is important to look beyond the existing body of HCI research and re-examine specific issues in the context of learning environments, the needs of children as users, and issues of gender.

The thrust of HCI research is that users should not have to adapt to the technology, but instead, the technology should be designed to support the needs of the users. Historically, computer users have been adults in the workplace, while today users can be any age and encompass many groups within society: male and females, young and old, and all cultural and economic groups, just to name a few. As the definition of user grows, HCI research is also expanding to encompass the wide variety of users interacting with technology. In order to fully understand the needs of these new users, we must also understand the context and the environment in which the systems will be used. It is because of this that new areas within HCI are developing such as Computer-Support for Collaborative Learning Environments (CSCL).

This paper presents three important research agendas for HCI. First, we must recognize that learning environments have very different goals and approaches than do workplace environments, and it is important to investigate issues within the context of learning. Secondly, it is important to look at the differences between adults and children in the context of computers. What works for adults will not necessarily work for children. Finally, it is important that we understand how each gender interacts with computers so as to not exclude any children.

While educational multimedia can be used by a wide variety of people in numerous settings, this paper will focus on educational multimedia for children in a school environment. This paper will present past and present research as well as directions for the future to help in the development of educational multimedia.

Learning: Workplace vs. Learning Environments

One of the primary goals for using computers in the workplace is to help improve workers productivity while learning is commonly a secondary goal. In contrast, learning is one of the primary goals for the use of computers in an educational environment. This, in itself, will cause users to view and interact with systems differently.

Usability Guidelines for the Workplace and Learning Environments

Researchers in HCI have developed a set of usability guidelines, and design and testing techniques to help improve the design of products for the workplace [Anderson & Olson 85]. Use of these guidelines for the design of educational multimedia products for children, while perhaps is useful, does not acknowledge the fact that learning environments are often different from workplace environments. [Robertson 94] has suggested that traditional usability design guidelines and usability testing methods need to be revamped for educational software.

Productivity vs. Entertainment

One of the most striking differences between individuals in the workplace and children in school is their motivation for using technology. At work, the motivation to use computers comes from the need to complete the task components of a job. While children also use computers to complete a task assigned by the teacher, the real motivation that children have to interact with technology is *enjoyment*. For computers to be effective for adults in the workplace, computers must be easy to use and help the individuals complete their day-to-day tasks. For computers to be effective for children at school, they must be fun. Several researchers have noted the potential benefit of educational software if it facilitates the children's motivation to play as observed when they play electronic games [Klawe 92, Soloway 91].

Collaborating on Multiple Networked Machines vs. a Shared Machine

One example of the difference between designing for the workplace versus the classroom can be seen in the area of Computer-Supported Cooperative Work (CSCW). The premise for many CSCW systems is multiple people, *each with their own machine*, working together towards a common goal. Often, these machines are networked together to support the collaboration. This could be in the form of a meeting support system or a shared word processor. In contrast, in the classroom, where learning is the ultimate goal, often the verbal discussion of ideas and hypotheses is a key component of the learning process. This may be best facilitated when the children are sitting side-by-side, talking face-to-face, both focusing on the same artifact. Therefore, a good approach in designing a Computer-Supported Collaborative Learning (CSCL) tool for use in a single classroom may be to focus on children collaborating on the *same machine*, and deciding how to best support this type of collaboration. Researchers have begun to explore the concept of providing a shared screen with multiple input devices to enable multiple children to work together on the same computer [Inkpen et al. 97b, Inkpen et al. 95, Bricker et al. 95].

Children: Adults vs. Kids

The computers that children use at home and at school for the most part look like the machines that you can see on most desks in the business world. We have taken a product, developed for adults in the workplace, and given it to children for school and play. How do we know that this machine is designed appropriately for children? Most of the software on these computers had been adapted for children but this adaptation has, for the most part, been designed in an ad-hoc manner. Very little research has been conducted on how to effectively design computer software for children. With computers becoming more prevalent in the education system, it is critical that we understand how children interact with computers and the most effective way to design the hardware and software.

Motor Skill Development

Some researchers have noted that children have difficulty performing mouse operations that require sustained pressure on the mouse button [Inkpen et al. 97a, Inkpen et al. 96, Stromme 94]. [Inkpen et al. 97a, Inkpen et al. 96] investigated two common mouse interaction techniques for children: drag-and-drop and point-and-click. A preliminary study looked at girls playing two different versions of the same computer game, one which utilized a drag-and-drop interaction style while the other utilized a point-and-click interaction style [Inkpen et al. 96]. This study showed that girls were able to solve more puzzles using the point-and-click version of the game than using the drag-and-drop version. In addition, girls using the point-and-click version of the game were also more motivated to play. A follow-up study examined children moving objects around on a screen using either a drag-and-drop interaction style or a point-and-click interaction style [Inkpen et al. 97a]. The results of this study suggested that a point-and-click interaction style was better for children than the drag-and-drop interaction style, based on children's preference, speed, and number of errors committed.

Cognitive Differences

A few researchers have begun to notice that adults' computer interaction styles are not necessarily appropriate interaction styles for children. [Berkovitz 94] noted that children have a lot of difficulty stretching a selection rectangle around a group of objects. Children often misplaced the initial point of the selection rectangle and therefore missed some of the objects that they were trying to select. Error in placement of the initial point could be attributed to two causes: 1) the inability of children to understand where the initial point should be placed in order have the box to encompass all of the appropriate objects, or 2) a lack of planning on the part of the children before initiating the action. [Berkovitz 94] suggested a selection technique that was more appropriate for children where they could "push out the edges" of the selection rectangle. This improvement not only allowed for the traditional method of dragging the mouse along the diagonal of the rectangle, but also enabled the children to use a circular gesture to define the selection rectangle.

Experiential Differences

These examples show how children have physical or cognitive difficulty using adult interaction techniques commonly found in children's computer software. We also need to be concerned about how the children make sense of the applications they are using. One particular design strategy in HCI is to design products that encourage users to form the correct mental model of a system. This can be accomplished by having the application use metaphors for something that the user is already familiar with [Norman 83]. Because children have different experiences and perspectives than adults, common adult metaphors may not make sense to children. One common adult metaphor found in software is the desktop metaphor but, as [Jones 90] states, this is not an appropriate metaphor for children. Children do not have much experience in office environments with file folders and in-out trays. Instead, child-appropriate metaphors should be used. [Jones 90] suggests that the best way to achieve this is through user-centered design.

These results emphasize the need to continue exploring HCI issues for children. Children are not adults: their motor skills are not fully developed, their cognitive capabilities are different, and their motivation for using computers is different. If we carelessly develop educational multimedia tools we may jeopardize our children's ability to learn with the tools.

Gender: Girls vs. Boys

Girls and boys interact differently with computers. Girls and boys think about computers differently, have different motivations for using computers, approach computers differently, have different preferences, and have even shown differences in the ability to use various interaction styles [Hall & Cooper 91, Inkpen et al. 95, Inkpen et al. 97a, Inkpen et al. 97b, Upitis & Koch 96, Lockheed 85, Wilder et al. 85]. Because of this, when designing educational multimedia, we must be sensitive to gender issues to ensure that the products developed are appropriate for children of both genders.

Gender Stereotypes in Electronic Games

Earlier research on children interacting in an electronic games environment found several difference between girls and boys [Inkpen et al. 94, Lawry et al. 95]. The differences included the types of games the children liked, what aspects of the games were important to them, and to what degree the games were a part of their social environment. Unfortunately, many electronic games are designed by men, for the young male market. Gender prejudices can be found in many electronic games that involve violence and use women as "objects" to be rescued [Provenzo 92]. This in itself is a major problem because often, electronic games are often a gateway for children to become involved with computers [Papert 93]. Not only is it important to develop products that are appropriate for both genders, it is imperative that the products developed do not promote the negative stereotypes of either gender.

Complexity of Gender Differences

Research must be conducted in order to begin to understand the complex nature of gender differences. Previous research had shown that software designers incorporate their own gender biases into the software that they develop [Huff & Cooper 87]. Often, these gender biases will cause the designers to miss important subtle nuances with respect to gender differences. For example, a math prototype game was developed for girls and boys. When playing with a partner, two modes of play were available: *compete* mode and *team* mode. Before presenting this game to children, researchers assumed that girls would prefer to play in *team* mode and boys would prefer to play in *compete* mode. The game involved having a frog hop around on lily-pads according to a mathematical problem. In *compete* mode, each partner had their own frog and their own score. In *team* mode, there was only one frog and both partners contributed to a single score. When the prototype was presented to children, the developers realized that their intuitions were wrong. The girls preferred to play in the *compete* mode because they could each have their own frog. For girls, the sense of identity, and character was important. Boys, on the other hand, preferred to play in *team* mode because they recognized that if they worked together, they could get the highest score in the whole class! Even though the boys were competitive, they were willing to cooperate with one person in order to have a higher level of success and compete with the rest of the class. This example demonstrates that the gender differences exhibited in a computer environment can be complex and easily misunderstood without proper research.

Gender Differences in Collaborative Environments

Qualitative, anecdotal observations are useful but quantitative data may also be required to sort out gender differences. Quantitative data on children's collaborative behavior was collected in a study which involved children played a puzzle-solving game in various collaborative set-ups [Inkpen et al. 97b]. The collaborative protocols included pairs of children playing the game with either one *shared* mouse or two mice. In the two-mouse conditions, two protocols were used to transfer control between the mice: *give* and *take*. In the two-mouse *give* condition, the partner in control of the game cursor would press their mouse button to pass control of the game cursor over to the other partner's mouse. In the two-mouse *take* condition, either partner could take control of the game cursor by pressing their right mouse button at any time.

The results from this study revealed that girls solved more puzzles in the two-mouse *give* condition than in either of the other two conditions. While the number of puzzles that boys solved in the various conditions was not statistically different, further analysis of boys sharing patterns revealed that boys exhibited quite different behavior in the three conditions. In the two-mouse *take* condition, boys demonstrated a more equal distribution of mouse time between the two partners than in the other two conditions. In addition, a correlation was found between how long each boy had control of the mouse during a collaborative session and how well they could perform later on their own. If our goal is to have all children benefit from the collaborative session, then an equal distribution of mouse time would be advantageous.

It is important that we continue to explore how both girls and boys interact with computers and ensure that all of our HCI research is sensitive to gender issues.

Advancing the Agendas

The three research agendas presented here, namely, learning environments, children, and gender all converge into one common focus: user-centered design. In order to design effective educational multimedia we must understand how children of both genders interact in a learning environment.

The project group E-GEMS (Electronic Games for Education in Math and Science) at the University of British Columbia and Queen's University is employing user-centered, participatory, design as its main research approach. Prototype educational games are being developed and tested with students in four elementary school as key participants in the design [Klawe & Phillip 95]. The E-GEMS classrooms (three in Vancouver, British Columbia and one in Kingston, Ontario), have each been equipped with four Macintosh computers. The teachers and students in these classrooms test out the prototypes and give valuable feedback. The children's feedback involves not only what they like and don't like about the game but also suggested improvements or enhancements. Beyond designing and testing games, E-GEMS is also examining how to incorporate educational electronic games into the classroom and the curriculum.

E-GEMS researchers also spend a great deal of time in elementary schools either having children try out their ideas or conducting studies on old or new interaction styles [Inkpen et al. 95, Inkpen et al. 97b, Sedighian 96]. In addition to elementary schools, E-GEMS researchers conduct research at Science World BC, an interactive science museum in Vancouver, British Columbia. By constantly working with children, the E-GEMS researchers and designers are always putting the needs of children first, and are always trying to better understand these needs.

Research on how to effectively design and use educational multimedia in a learning environment, for girls and boys, has still only scratched the surface of the iceberg. Continued research is needed, with the emphasis on user-centered design. Merely creating educational software and placing it in front of children is not enough.

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The Evolution Thematic Investigator: Research and the Design of Hypermedia Learning Environments

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Abstract: This paper describes the main design features of a case-based hypermedia learning environment, the *Evolution Thematic Investigator*, that was developed as part of a research project into learning complex biology knowledge at the high school level. This hypermedia program has a number of features based on recent cognitive learning theory and research, such as: conceptual change lesson, multiple cases of evolutionary biology, case-theme commentaries to make explicit the situated variability of the neo-Darwinian mental model, on-line scaffolded problem-solving modules, and guided thematic criss-crossing of knowledge synthesis study questions. Research into student learning associated with the use of the Evolution TI has found significant conceptual change from predominately naive Lamarckian models being used by students to solve evolutionary biology problems on the pretest to neo-Darwinian models on the posttest and again at a one year follow-up study. This paper focuses primarily on the design features of the Evolution TI as an exemplar of a case-based hypermedia learning environment.

It may be argued that traditional instructional approaches are not well-suited for helping students deeply learn centrally important but difficult to understand domain concepts and mental models (Brown, Collins, & Duguid 1989; Cognition and Technology Group at Vanderbilt 1990; Collins, Brown, & Newman 1987; Glaser 1991; Spiro, Feltovich, Jacobson, & Coulson 1992). However, merely providing access to technological learning systems such as powerful multimedia computers are unlikely to lead to substantive learning of knowledge (Jacobson, Maouri, Mishra, & Kolar 1995; Neuman, Marchionini, & Morrell 1995). Principled design approaches for hypermedia learning environments (HLE) are needed to inform both the design of the technology itself and the learning activities and conditions under which HLE can be used to help promote substantive learning [Jacobson 1994].

The HyperBio Project has been part of a program of research into issues such as these [Jacobson & Spiro 1994]. In particular, the HyperBio Project has investigated ways hypermedia can be designed and used to achieve three main goals: (a) acquisition of *deep understandings* of centrally important and difficult domain knowledge, (b) *conceptual change* of naive domain models, and (c) ability to *transfer* or *apply* knowledge to new situations. This paper will focus on HyperBio Project research into learning the neo-Darwinian theory of evolution by natural selection.

From a research perspective into learning with HLE, the domain of evolutionary biology is particularly interesting. Understanding neo-Darwinism is absolutely essential to contemporary biology [Dobzhansky 1973], yet the core concepts of evolution by natural selection are significantly more difficult for students to grasp than most biologists and science teachers imagine [Bishop & Anderson 1990]. Further, there is evidence that most students will need to go through a process of conceptual change from a naive "Lamarckian" model (i.e., traits acquired by the parents are passed on to the offspring) to the scientifically accepted neo-Darwinian model (i.e., evolution occurs by a process whereby organisms have traits that are differentially suited for surviving in specific environmental niches and thus living long enough to reproduce and pass on their genetic material--that is, they are naturally selected) [Bishop & Anderson 1990; Brumby 1984; Greene 1990; Jacobson, Sugimoto, & Archididou 1996; Settlage 1994]. As discussed below, specific features of the Evolution Thematic Investigator (TI) were designed to address the conceptual change issue. Our research into student learning associated with the use of the Evolution TI has found significant conceptual change from mainly naive Lamarckian models used by students to solve evolutionary biology problems on the pretest to predominately neo-Darwinian models on the posttest and at a one year follow-up study [Jacobson & Archodidou, in press; Jacobson et al. 1996].

This paper will focus primarily on the actual design features of the Evolution TI as an exemplar of a case-based hypermedia learning environment. In the next section, these various design features and learning activities are discussed.

Evolution Thematic Investigator

The Evolution TI has seven main components that were used in this study: (a) a *conceptual change lesson* on evolution, (b) *multiple cases* of evolutionary biology, (c) presentation of a *neo-Darwinian model of evolution with five core themes*, (d) *case-theme commentaries* to make themes of the neo-Darwinian model explicit in the context of different case examples, (e) *mental model visualizations* of both naive Lamarckian and expert neo-Darwinian evolutionary models, (f) *scaffolded problem-solving* with the interactive Story Maker modules, and (g) *guided thematic criss-crossing* with knowledge synthesis study questions. These seven major features of the Evolution TI are briefly discussed in turn.

Conceptual Change Evolution Lesson

As noted above, prior research has established that many students enter biology classes with a strongly entrenched naive Lamarckian mental model. A computer-based evolution conceptual change lesson was developed that implemented the basic recommendations of a conceptual change approach to science education: (a) create dissatisfaction with existing conceptions, (b) make a new conception intelligible, (c) make a new conception appear initially plausible, and (d) demonstrate how a new conception can open up additional areas of inquiry (Posner et al. 1982; Strike & Posner 1990). The evolution conceptual change lesson presented naive Lamarckian and neo-Darwinian mental model visualizations (see below), discussed the inadequacies of the naive model of evolution, and demonstrated how the neo-Darwinian model could successfully be used in place of the naive Lamarckian model.

The lesson initially asked the students to articulate their knowledge about evolutionary biology in two ways. First, they ran two evolution mental model visualizations, one representing a naive Lamarckian model and the other a neo-Darwinian model. They were then asked to select which one was closest to their understanding of how evolution occurred. The students also were asked to use the Story Maker (see below) to propose a solution to a classic evolutionary biology problem: How did giraffes evolve long necks?

The text of the Evolution and Natural Selection lesson was *not* written to convey to the students that they might have the "wrong" ideas about evolution and that the Evolution TI was going to teach them the "right" ideas about evolution. Rather, the lesson discussed the core ideas of two competing scientific views of evolution, Lamarckism (referred to in the lesson as the Developed Traits Scientific Story) and Darwinism (referred to as the Natural Selection Scientific Story; see [Tab. 1].

Multiple Cases of Evolutionary Biology

Four different hypermedia-based cases of evolutionary biology were developed: *The Peppered Moth*, *Antibiotics and Drug Resistance*, *Anglerfish*, and *Rabbits in Australia*. These cases illustrated central themes of neo-Darwinian evolutionary theory. In addition, these cases depicted evolutionary phenomena that were intended to be interesting, distinctive, and relevant. For example, the *Antibiotics and Drug Resistance* case discussed the relevance of neo-Darwinian evolution by natural selection to an important contemporary health issue. Another case, *Anglerfish*, dealt with a variety of fish that have a particularly distinctive anatomical feature: they have appendages in place of the top dorsal fin that are used as lures to "fish for other fish." The various cases of evolutionary biology illustrate the situated or contextual variability of knowledge while making salient the deep conceptual structure of this domain, that is, the neo-Darwinian model of evolution by natural selection.

Central Themes for Neo-Darwinian Model

The contemporary neo-Darwinian theory of evolutionary biology is quite elaborate and complex. The purpose of this study, however, was not to have students learn evolutionary biology at the level and depth of a professional biologist. Instead, this research focused on having students acquire a mental model based on core components or themes of neo-Darwinism. Five neo-Darwinian themes were selected for this study: (a) Environmental Conditions, (b) Population Variety, (c) Natural Selection, (d) Origin of New Traits, and (e) Generations and Time. [Tab. 1] lists the core components of each of these themes as they are instantiated in the neo-Darwinian and naive Lamarkian models. General theme descriptions were available from most portions in the program.

Case-Theme Commentaries

Case-theme commentaries made explicit how structural dimensions of knowledge (e.g., the neo-Darwinian themes) applied in various case-specific or situated contexts (Jacobson et al. 1995; Jacobson & Spiro 1995). The Evolution TI provided case-theme commentaries in which the neo-Darwinian themes were discussed in terms of specific details in the evolution cases. For example, the theme of Population Variety had a case-theme commentary in the Peppered Moth case that pointed out the variations in the wing colorations of these moths. In the case of Antibiotics and Drug Resistance, the Population Variety commentary discussed the variation in bacterial resistance to antibiotics.

Mental Model Visualizations

Newly available visualization technologies are allowing dramatic, animated, scientific images to represent complex scientific data (Gordin & Pea 1995). Scientific visualizations have been primarily used to provide representations of quantitative data for complex phenomena (e.g., weather data) and are typically based on expert scientific models about the phenomena under investigation. We have been developing another approach to using visualizations for learning that we call *mental model visualizations*. Our intent was to create computer-based visualizations that *reified mental models* held by learners and experts. In contrast to scientific visualizations, the mental model visualizations we have developed are qualitative in nature and are based on cognitive analysis of novice and expert mental representations about a particular domain. In terms of this specific study, the evolution mental model visualizations were intended to *make neo-Darwinian thinking visible* to students by providing computer animated representations about evolutionary biology to supplement the case, theme, and case-theme commentaries that were primarily textual. Four neo-Darwinian visualizations and one naive Lamarckian evolution mental model visualization were created (based partly on the research of Bishop & Anderson 1990).

Evolution Themes	**Neo-Darwinian Model**	**Naive Lamarckian Model**
Population Characteristics	Population *variety* essential for evolution through natural selection	Population *homogeneity*; small individual differences do not matter for evolution
Environmental Conditions	"Neutral" environment; varying & dynamically changing environmental conditions	Environment "creates" need that causes the organism to change
Mechanism of Inheritance	*Natural* selection; individuals with advantageous traits (genetically predetermined) more likely to survive and reproduce.	*Acquired traits*; traits partially developed by parents passed on to off-spring
Origin of New Traits	Random changes in genetic material: 1. Mutations 2. Sexual recombination	Species changes due to: 1. Environmental need 2. Use or disuse
Generation and Time	Evolutionary changes require cycling of generations; time scales vary from hours to thousands or millions of years	Acquired traits gradually change entire population over time

Table 1: Core components of naive "Lamarckian" and expert Neo-Darwinian evolutionary biology models

The evolution mental model visualizations were developed using MacroMedia Director 4.0. Five evolution mental model visualizations were created (e.g., naive Lamarckian for "Bugs" conceptual change example; neo-Darwinian for "Bugs" conceptual change example; neo-Darwinian mental model visualization for Peppered Moth case,). Each of these followed the same basic template in which the learner stepped through the mental model visualization with short informational text augmenting the graphics in four to eight different environmental situations selected by the learner. Other features of the evolution mental model visualizations included an Overview screen showing all of the branching options with thumb-nail figures, a Thumbnail summary of the generational changes on the left side of the screen, and a Case Information icon that provided an abstract of the particular example or case on the lower right side of the screen.

Other Program Features

There were two additional features of the Evolution TI: *scaffolded problem-solving* with the Story Maker and *guided thematic criss-crossing*. The Story Maker modules provided interactive, scaffolded problem-solving activities. Students were given evolutionary biology problems to solve, such as "How did giraffes get their long necks?" They would then select from a pool of randomly arranged statements consistent with naive Lamarckian and neo-Darwinian models on the left side of the screen. The statements they selected would each be changed to an italics style and then copied to the right side of the screen. Statements on the right side could be reordered or removed. When the students were satisfied with the statements they had selected, the program would evaluate the response and provide brief feedback about whether their answer was similar to the Lamarckian scientific view of evolution by acquired traits associated or to the now accepted neo-Darwinian view of evolution by natural selection.

The Evolution TI program also provided *guided thematic criss-crossing* (Guided TCC) in conjunction with *knowledge synthesis study questions* [Jacobson et al. 1996; Jacobson & Spiro 1995]. Knowledge synthesis questions asked the students to consider issues and problems that required the integration of information distributed across the hypermedia case materials they had been studying. Previous research suggests that students who are novices in a domain have difficulty with learning and integrating conceptual knowledge in hypermedia materials [Jacobson 1996; Neuman, Marchionini, and Morrell 1995]. Guided TCC provided cognitive scaffolding to demonstrate the conceptual interconnectedness of knowledge in the hypermedia cases through the use of different sets of hyperlinks based mainly on neo-Darwinian thematic indices. These different sets of hyperlinks were tailored to specific knowledge synthesis questions in a manner that has been found to contribute to learning for transfer in previous research [Jacobson 1996; Jacobson & Spiro 1995].

Conclusion

This paper has discussed the main design features of the Evolution Thematic Investigator case-based hypermedia learning environment and some of the learning activities which employed this system in a study of conceptual change and evolutionary biology. While these design elements have been instantiated here in the domain of evolutionary biology, other research by our group is suggestive of ways that case-based hypermedia learning environments with conceptual indexing can be created for other domains ranging from the social impact of technology and military strategy to bio-medicine [Jacobson, Maouri, Mishra, & Kolar 1996; Jacobson & Spiro 1995; Spiro, Feltovich, Jacobson, & Coulson 1992]. Other research is being planned that seeks to explore ways that newly available visualization, modeling, and immersive technologies might be integrated into case-based learning environments in a cognitively and pedagocically principled manner [Jacobson 1996]. Elaborating on those ideas, however, is a story for another day.

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Visualization Strategies for Learning Recursion

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Abstract: Modern computer technology allows precise coordination of text and graphic information and may provide learners with tools for enhancing acquisition of abstract and complex programming knowledge. This study explored the hypothesis that an electronic learning environment with appropriate graphic representations can facilitate abstract knowledge acquisition when students learn recursive procedures. In this study, college students were taught to learn the Scheme programming language and the concept of recursion in the three learning conditions: on-line Scheme recursive procedures, in which dynamic visual notations (e.g., colored icons and environment trees) accompanied to progressively represent intermediate steps of each procedure's run-time state; on-line Scheme recursive procedures, in which an ordered sequence of static pictures accompanied to explicate each procedure's run-time process; on-line Scheme recursive procedures with merely textual explanation. Results of this study indicate that limited textual information with rich and appropriate animated or static graphic representations can provide students a better framework for understanding the concept of recursion.

Key words: Language learning, Visual thinking, Mental model building

Introduction

The ancient proverb, "a picture is worth a thousand words", has already characterized the efficiency of external visual representations for communicating ideas. Visualization strategies of learning and problem solving have provided a good number of historical accounts of scientific discovery and invention [Ferguson, 1977; Rieber, 1995]. For example, mathematicians have made extensive use of diagrams to solve geometric problems. Scientists in the domain of physics and chemistry also have utilized a vast amount of diagrammatic information to analyze and interpret data. Research has indicated that textual information with appropriate adjunct visual aids can enhance reading comprehension [Bransford & Johnson, 1972; Sharp, Bransford, Goldman, Risko, Kinzer, Vye, 1995]. Even though visual information is not available, readers still try to utilize visualization strategies to form mental imagery to comprehend texts [Anderson & Kulhavy, 1972]. Thus, visualization strategies for learning and problem solving pervade all people.

Some investigators have contended that the form of human mental representation is purely propositional [Pylyshyn, 1973], while others considered that the form of internal propositional representation is different from that of visual imagery, and people are able to encode information in these two different forms [Paivio, 1990]. Although the controversy about distinguishability of these two types of mental representation can not immediately be resolved, different forms of external representation indeed affect human cognition differently. Even for textual information, relevant research has indicated that when two texts that are informationally equivalent but represent things with different propositional forms may cause people construct different situation models to represent what is described in the text [Kintsch, 1986; Perrig & Kintsch, 1985]. For example, people read a text describing a city in geographic terms (e.g. The general store is on the southern end of the Main street) will represent information about locations differently from people who read a text describing routes and places of that city (e.g. Returning on the Main street to the other end, you come to the general store). Studies have also indicated that the acquisition of spatial knowledge through two different representational forms can cause people mentally represent information differently [Thorndyke & Hayes-Roth, 1982]. For the instructional purpose, it is important to know whether certain knowledge should be represented with pictorial information so that learners can acquire and comprehend that knowledge more efficiently than would be the case that the knowledge is represented with textual information.

Visual representations are different from textual information in that visual representations mainly consist of spatial (i.e. typological and geometric relations among the objects or events), nonarbitrary (i.e., the quality of visual information resembling actual objects and events), and continuous (i.e., an "all-in-oneness" quality) characteristics [Larkin & Simon, 1987; Paivio, 1990; Rieber, 1995]. Text-based representations are arbitrary and sequential (e.g., readers usually read a text based on its semantic sequence instead of randomly scanning a picture of it), and may reflect temporal and logical relations among external events. In addition to preserving characteristics of visual information, dynamic visual representations or an ordered sequence of static visual representations are able to represent temporal and causal relationships between states [Freyd, 1987].

Most programming languages lack properties to explicitly demonstrate intermediate steps of a running program. This makes it difficult for beginners to learn to write computer programs. For example, the run-time phenomenon of a recursive procedure usually is not visible and also difficult to describe with merely textual information. As a result, learning the concept of recursion becomes a major hurdle for most novice learners. Since dynamic visual representations or an ordered sequence of static visual representations are able to capture characteristics of most objects or events, they are best suited to explicitly represent complex programming concepts, such as recursion, and may assist students to learn.

The development and increased availability of the multimedia technology allows objects and events to be represented with dynamic or static visual forms. Several multimedia instructional systems with a dynamic visual display of knowledge have been developed for math and science instructions. Some of them have been proved to be effective [Dugdale, 1994; Klotz, 1991; Jehng, Liang, Shih, & Chan, 1994]. The use of multimedia with dynamic or static visual representations has its instructional advantages for learners to acquire abstract knowledge. First, a multimedia learning environment with appropriate visual information could provide more visual cues (e.g. colors, icons, flash light and reverse video) to illustrate certain significant and important aspects of abstract knowledge. Second, a multimedia learning environment with appropriate external visual displays of knowledge may reduce learners' cognitive load during learning, more memory capacity can be released so that conscious processing can be devoted to higher-level cognitive operations as necessary. Finally, a multimedia learning environment with visual representations usually can characterize different aspects of knowledge and make knowledge more explorable. Students are more likely to construct their own mental models to understand that knowledge and work toward more encompassing explanations.

This study attempted to investigate whether students who just begin to study the concept of recursion and learn to trace execution steps of recursive procedures in a multimedia learning environment with either dynamic or static visual support would learn the concept and the programming skill effectively and demonstrate a superior problem solving ability than those who learned in a multimedia learning environment with only textual information provided. The concept of recursion is complex and abstract, and many programming languages fail to explicitly illustrate the execution steps of recursive procedures at the run-time so that learning recursion could be difficult for novice learners. The multimedia learning environment provides either dynamic or static visual representations can be an efficient approach to capture and teach the deep structure of the concept of recursion and make it easier to learn. Results of this study should provide us an understanding of how a multimedia learning environment with appropriate visual representations can help teach and learn complex programming knowledge.

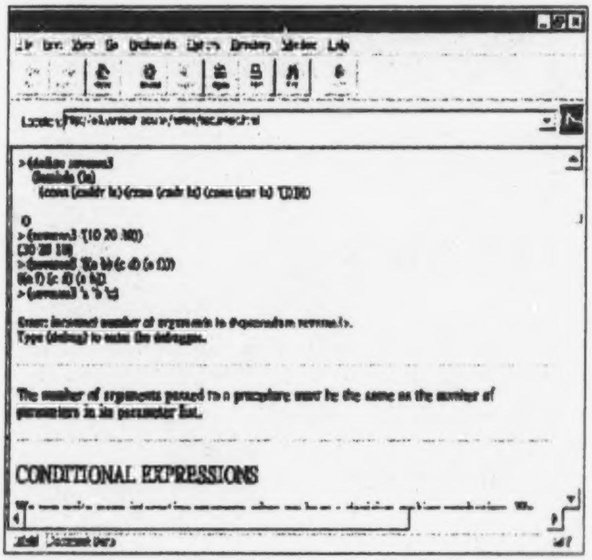
Methods

Participants Subjects in this study were 38 senior students from the Department of Management Information Systems at the National Yunlin Institute of Technology, Taiwan. They participated in this study for fulfilling requirements and earning credits on a programming language course. All of them, having learned to program in a few introductory computer science courses, did not learn the Scheme programming language before and had minimum knowledge about the concept of recursion.

Materials and Design Subjects were randomly assigned into the three conditions to learn the concept of recursion. At the initial lecture session, subjects in each group were introduced the

Scheme language and the concept of recursion using an on-line text without any ancillary visual representations. They were, then, asked to review what they had learned in three different conditions. The review materials designed in the three conditions were informationally equivalent with different presentation formats. In the control condition, 12 subjects would review the same on-line text without any visual aids. Thirteen subjects in the first experimental condition would read an on-line text with an ordered sequence of static graphic information accompanied to illustrate the execution process of recursive procedures. For the control and the first experimental condition, the learning materials were compiled into HTML files and presented in the WWW environment where students reviewed the materials using the Nescape 3.0 application. In the second experimental condition, 13 students would review what they had learned with the RainbowScheme system, which allows the evaluation steps of a Scheme recursive procedures to be presented step by step in an algebra form. This learning environment used high-level visual objects, such as colored Scheme expressions, clickable icons, and colored environment trees, to represent each Scheme recursive procedure's run-time state. The visual information provided in the two experimental conditions applied one or more *Visualcode* rules. *Visualcode* is a graphical representation of Scheme's operational semantics [Tung, 1996].

Procedure A randomized block design model was used that the students' achievement in computer programming related courses was regarded as control variable. Students were randomly assigned into three groups. Subjects in each group first received a two-hour lecture from the instructor about the Scheme language and its simple recursive procedures from an on-line text. The material was projected and presented on a big screen inside a classroom with an overhead projector connected to a computer. Subjects were then asked to review what they had learned from the lecture in three different conditions. The first group of subjects were assigned into the control condition where subjects were arranged to review the material with the same on-line text as in the lecture session. Subjects in the second group would study an on-line text with an ordered sequence of static pictures accompanied to demonstrate the execution process of recursive procedures. The third group of students would review the lecture material by working with the RainbowScheme system, that allows students to study the text with dynamic pictorial representations. Figure 1, 2, and 3 show the computer screens of the three learning conditions. All subjects took two hours to review the instructional materials individually. After the experiment, they were requested to take a test on recursion.



The number of arguments passed to a procedure must be the same as the number of parameters in its parameter list.

CONDITIONAL EXPRESSIONS

Figure 1. Recursive procedures with textual explanations

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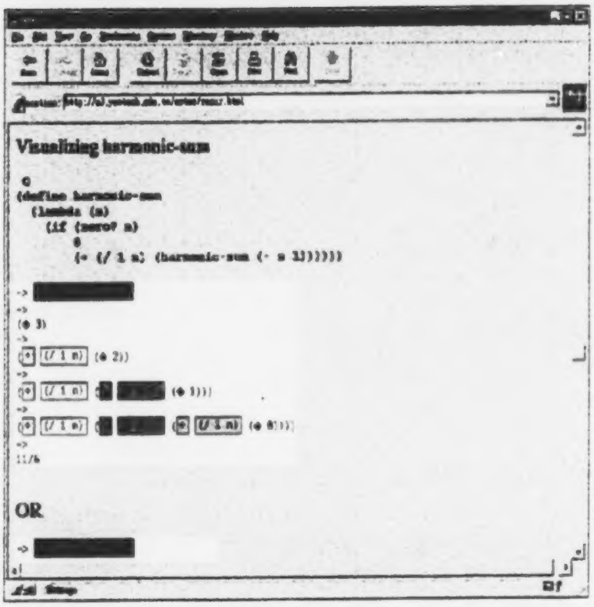

Visualizing harmonic-sum

```
(define harmonic-sum
  (lambda (n)
    (if (zero? n)
        0
        (+ (/ 1 n) (harmonic-sum (- n 1))))))
```

Figure 2. Static pictorial representations of recursive procedures

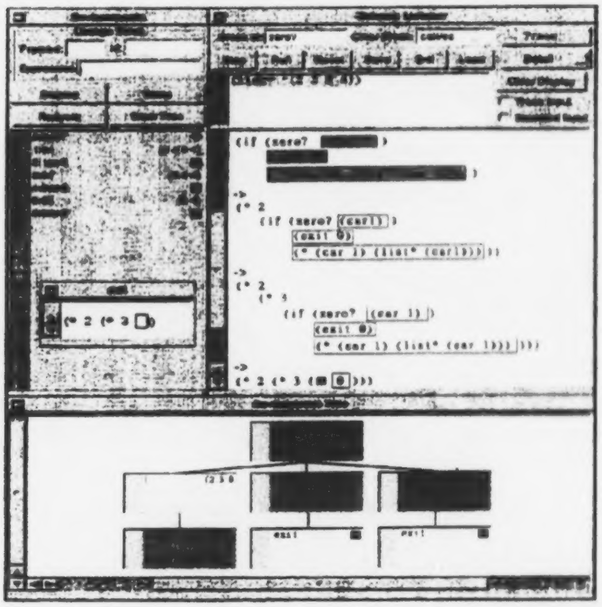

Figure 3. Dynamic pictorial representations of recursive procedures in RainbowScheme learning environment

Post test materials The post-test measure contains 12 problems: three of which were *evaluation* problems requiring students to evaluate Scheme recursive procedures by predicting results; another three of which were *diagnosis* problems requiring students to diagnose faulty Scheme recursive procedures and make corrections of them; another three were *fill-in-blank* problems requiring students to finish incomplete Scheme recursive procedures; the final three were *programming* problems requiring students to define and complete Scheme recursive procedures on their own. Evaluation and diagnosis problems mainly examined students' capabilities of tracing and evaluating recursive procedures; fill-in-blank and programming problems examined students capabilities of defining and completing recursive procedures. The post-test lasted one hour and forty minutes.

Data Analysis and Results

Student's scores on the evaluation and diagnosis tests were combined to represent their program evaluation skills, and their programming skills were measured by the fill-in-blank and programming tests. An ANOVA analysis of student overall performance in the post-test showed that students who studied in both experimental groups significantly outperformed those who studied in the control condition with F = 4.196 ($p < .05$). The average scores of student overall performance in the static pictures, dynamic pictures and control group are 7.42, 6.79, and 4.86 in sequence. The result of the Duncan's priori pairwise comparison analysis indicated that students' overall understanding of Scheme recursive procedures is enhanced with the aid of external visual representations. Specifically, analyses of student performance on the post-test measure showed that the three groups of students demonstrated different programming skills, but not the program evaluation skills. Subjects in the two experimental groups significantly outperformed those who studied in the control group in the programming skill test with F = 4.277 ($p < .05$). The average scores of student performance in programming skill test for the static pictures, dynamic pictures and control group are 3.29, 3.19, and 1.83 in sequence. The result of the Duncan's priori pairwise comparison analysis indicated that visual aids can help students improve their programming skills, but not the program evaluation skills. Although statistics did not show any significant differences in student performance on the program evaluation test, subjects in the two experimental groups still had higher mean scores than those who in the control group. Table 1 shows that results of the analysis.

Table 1. Student performance on the post-test measure.

	Static-pictures (N=13)	Dynamic-pictures (N=13)	Control (N=12)	F-test	Prob.
Evaluation skill	4.13(1.15)*	3.60(1.31)	3.03(1.43)	2.236	.1219
Programming skill	3.29(1.36)	3.19(1.49)	1.83(1.29)	4.277	.0218
Overall	7.42(1.98)	6.79(2.45)	4.86(2.41)	4.196	.0232

* indicates mean score with standard deviation in parenthesis.

Closing Commentary

Results of this study support the claim that textual information with appropriate ancillary dynamic or an ordered sequence of static visual representations can assist students to learn to trace recursive procedures and understand the concept of recursion efficiently. Students demonstrated superior problem solving skills in diagnosing, tracing and defining recursive procedures after they had learned the concept of recursion in a condition where dynamic and an ordered sequence of static pictorial representations simulated the computer behavior demonstrating the execution process of recursive procedures. Dynamic and an ordered sequence of static pictorial representations showed qualitatively different effects on students' intellectual performance and capabilities. Such an usage of computer technology may expedite the acquisition of the knowledge that students are always required to learn.

The reason that account for the significant effect of dynamic and an ordered sequence of static pictorial representations on learning of recursion could vary. First, dynamic and an ordered sequence of pictorial representations are capable of explicitly displaying intermediate steps of the execution process of recursive procedures; this allowed students to analyze a recursive procedure's run-time state easily and quickly identify its concept structure. The step-by-step demonstration facilitates students to build their own mental models to precisely interpret what they were learning from the screen. Whereas, the textual information is not able to demonstrate the run-time state of a recursive procedure in transition. It is more difficult for students to construct their own understanding by making sense of what they were reading from the screen. An alternative account is that dynamic and an ordered sequence of static pictorial representations can reduce students' cognitive load and free students from lower level and tedious cognitive operations that exceed their cognitive capacities during learning. Psychological research has indicated that people has a tendency to form a dynamic mental representation and make accurate inference of a moving objects from an ordered sequence of static display [Frayd, 1983; 1987]. With the aid of dynamic or an ordered sequence of static pictorial display, students do not need to conduct much conscious processes to mentally simulate computer execution of recursive procedures. It is easier for novice learners at the initial stage of learning readily comprehend a complex and abstract concept of recursion and accurately interpret the execution process of a recursive procedure without expending much mental efforts. Meanwhile, dynamic or an ordered sequence of static visual representations allow students to perceive execution process of recursive procedures in real time changes. Students do not have to take much intellectual effort as those students in the textual information conditions to infer, analyze, and predict intermediate steps of program execution. More working memory capacity can be released for higher level cognitive operations so that in-depth processing of knowledge is possible.

Finally, dynamic and an ordered sequence of static pictorial representations are capable of representing different aspects of the concept of recursion and make the knowledge more explorable than the form of textual representations. The form of dynamic and an ordered sequence of static pictorial information is capable of representing the temporal features of execution processes of recursion and logical relationships between transitions so that students can readily see how a recursive procedure is being executed and can mentally simulate that process. Students can perceive and compare different kinds of recursive procedure's run-time phenomena represented by the two types of visual information. For example, students can perceive and compare the execution processes between tail and non-tail recursive procedures and accurately relate differences of their execution processes to the program structures. The concept of recursion become more explorable and analyzable.

The notion that computer can be used for cognitive tools for enhancing learning has been proposed by many educational researchers [Pea, 1985; Salomon, 1988; Salomon, Perkins, & Globerson, 1991]. The research discussed in this paper suggests that a multimedia learning environment that provides appropriate dynamic or an ordered sequence of static pictorial representations can be used for facilitating acquisition of complex and abstract programming knowledge. Student can envision what they have learned and their novel thoughts can be extended to more powerful problem solving ideas through visualization strategies. Future research should explore more effective visualization techniques with computers for teaching and learning abstract and complex knowledge.

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MacSQEAL: A Tool for Exploration of Hypermedia Log File Sequences

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Abstract: In this paper, we present an exploratory technique for investigating student interaction with hypermedia. We describe a tool for exploratory sequential analysis of the transformed data and present examples of how this tool has been used to analyze a large collection of log files. We describe our data source to provide context for analyzing the data, discuss an innovative way to investigate sequences in log files, and provide examples of results obtained from our method.

1 Previous Work: Methods for Log File Analysis

Researchers examining how students use hypermedia software systems often analyze the student interaction with the software as recorded in a database [Ambrose 91]. These data are commonly referred to as "event recordings" or "log files," for they contain a log or record of choices or events within the software. There are several advantages to automated event recordings, as described by [Guzdial et al. 96]:

- Data collection is completely unobtrusive.
- Data are collected during actual use in an authentic context, which improves the ecological validity of the study.
- Data can be easily collected for a large sample of students over time.
- Data can be compared between students or over time for a single student.

Automated event recordings yield a vast amount of high fidelity data [Jackson 90]. This high volume challenges researchers trying to make sense of the data, and attempting "to make useful conclusions from essentially intention-free data" [Guzdial et al. 96, p 2].

One of the goals of log file analysis is to identify prominent patterns of use [e.g. Horney 93; Hutchings et al. 94] and correlate those with other quantitative measures such as ACT scores [Beasley & Vila 92]; however, many such studies are weak in interpreting these results and the implications for design or learning. These techniques suffer from a lack of specific detail: why did these students use a certain feature and ignore another? what are the students' goals, objectives, motivations, strategies? [Jones et al. 96] suggest that a combination of log files and interview data could be used to address such questions. The analysis of interviews could suggest hypotheses about student use; and these hypotheses could be checked against the larger data set.

Numerous techniques have been explored for making sense of log files. [Chen et al. 95] reviews existing techniques. [Guzdial et al. 96] contrasts methods used by a different research groups, applied to a single hypermedia system. According to Guzdial et al., there are two types of questions to investigate with log files: (1) determine aggregate measures used to characterize a given student or session (e.g. how many times did they look at a particular media type? how often were articulation actions followed by reflection?), and (2) examine the sequences of actions taken by a given student. In reference to sequences, the two techniques discussed by Guzdial et al. are measures of differences and similarities, and visualizations of event orderings. Similarity matrices are used to characterize the overall process used by a student – e.g. 30% of the time they went from A to B, but 10% they went from A to C – and identify groups of similar students (by applying multi-dimensional scaling or cluster analysis to the similarity matrix). Visualizations provide imprecise, but intuitive insight into sequence patterns that emerge when sequences are mapped into graphics. [Jackson 90] describes a very different technique for examining sequences, by applying sequence comparison methods from biology and geology.

Unfortunately, these techniques are not scalable or tolerant of the wide variation in event patterns characteristic of our data. We needed a speedy and flexible tool to perform ad-hoc sequence queries based upon hypotheses formed from interview data.

This paper extends [Jones et al. 96] by showing how hypotheses generated from interviews can be tested in the larger sample. We will describe our data source to provide context for the analytic method, discuss an innovative way to investigate sequences in log files, provide examples of results obtained from our method, and conclude with implications and future work.

2 Data Source

2.1 Context

The research reported here is part of a larger study examining the use of *Seeing Through Chemistry* in the context of the introductory chemistry course at a large midwestern research university. The design of the larger study is naturalistic. We used a variety of data collection techniques – scores, surveys, interviews, etc. – and a combination of micro- and macro-level data analysis from both quantitative and qualitative perspectives to examine the impact of *Seeing Through Chemistry*.

Seeing Through Chemistry (STC) is a multi-faceted hypermedia learning environment designed to facilitate students' development of conceptual understanding in introductory chemistry [Dershimer & Rasmussen 90]. STC's design applies psychological principles of learning and human-computer interaction [Dershimer et al. 92]; in particular, cognitive flexibility theory [Spiro et al. 88]. The six modules within STC correspond to key topics in the first-semester course. Within these modules, students must synthesize several concepts in order to answer each of a series of inquiry question. The inquiry questions have two parts: a multiple-choice component and an explanation; students must type an explanation before they can check the accuracy of their choice.

Throughout the term, students were required to answer the inquiry questions for five of the six modules in *STC* and turn in the printed version of their responses (the printout shows their initial and final response to each question). During the student assignments, *STC* automatically captured the sequence and duration of choices made by the student. Furthermore, it recorded all answers and revisions typed in response to inquiry questions. This information was captured to log files, one per student, so that each log file records completely a student's use of *STC* throughout the semester.

2.2 Characteristics of the Data

200 of the 450 students enrolled in this multi-section large lecture course agreed to participate in the study; we have log files for each participating student. In addition, we selected a stratified random sample of 12 students (based on background in math & science, and experience with technology) for more intensive participation. This target group participated in stimulated recall interviews for two modules, based on the trail map representation of their log file. These interviews played a significant role in the current analysis.

[Tab. 1] displays some characteristics of the modules in *Seeing Through Chemistry* and how students in this sample used the modules. Overall, there were 121,390 distinct events logged for this sample of students.

Module	Unique Events	N	total events per student	range	unique events	total time (min)
Spectroscopy	100	198	μ=175	25-455	54.5	78.7
ReDox	70	194	μ=113	32–315	38.2	48.7
Properties & Structures	102	195	μ=145	12–374	25.4	55.6
Acids & Bases	58	191	μ=95	26–289	13.9	39
Solubility & Precipitation	52	182	μ=95	13–253	14.3	39.9

Table 1: Characteristics of Student Use of *Seeing Through Chemistry*

We have identified potentially important characteristics of student use through interview analysis and log file visualizations. However, it is not practical to extend such an in-depth investigation to a sample of 200 students. To that end, we created a set of tools for processing the log files and performing ad-hoc queries on sequences. The queries we form are grounded in an awareness of the behavior of the target group.

3 Our Technique

Our tool is called MacSQEAL (which stands for Macintosh-based Sequence Query Engine for Analyzing Logs). It is built using the cross-platform programming language Perl [Wall 89], and achieves its flexibility by making extensive use of Perl's pattern matching capabilities.

We use three steps to transform our log files into sequences appropriate for MacSQEAL:

- convert events into more abstract representations
- recode for selective distinctions

- segment into sequences

MacSQEAL searches the transformed data for sequence patterns. The researcher specifies sequence patterns using extended regular expressions, as defined by the Perl programming language. MacSQEAL also provides a number of functions that restrict searches to specific modules, questions, or other selection criteria.

To date, we have used the tool primarily in two different ways: to extract aggregate data (e.g. how many students use a question–card–response pattern for Question 2 in the Acids & Bases module?) and form more complex queries (e.g. of those students who demonstrated a question–response pattern for Question 2 in Acids & Bases, which ones also exhibited this pattern for Question 4?).

3.1 Data Transformation

Step 1: Event Conversions/Abstraction. Abstraction is necessary when a log file contains a large number of relatively uncommon events. For example, a module in STC contains roughly 50 to 110 distinct events [Tab. 1], that correspond to a much smaller set of types: concept map (m), content card (c), inquiry question (q), response (r), animation (a), video clip (v), experiment (e), focus question (f).

Step 2: Selective Distinction. Some kinds of analysis require more precise discriminations between events than the abstraction step provides. For example, for any given inquiry question in *STC* there are "relevant" cards (they appear on a list of topics that should be contained in the ideal answer). When examining how students construct their explanations for the inquiry questions, we are interested in whether or not they examined "relevant" cards; as a result, we recode the sequences to distinguish between "relevant" (uppercase C) and other content cards (lowercase c).

Step 3: Segmentation. We segment a log file into interesting pieces to provide basic units for pattern matching. The literature suggests several alternatives, such as session (for multi-session log files) or chunks of time (perhaps standardized, as in [Chen et al. 95]).

Based on student interviews, we determined that the sequence of actions involved in answering an inquiry question was key to understanding how these students use STC in their chemistry course. As a result, we segmented the log files by question. For each log file, we first combine all actions that occur between initialization and the first visit to any question; then we create segments corresponding to the sequence of actions for a given question. A new segment is created when the student goes to a new question.

The first five Acids & Bases segments for a sample student are shown in [Tab. 2]. The first two lines reveal that this student visits a large portion of the module before visiting the first question ("overview" refers to a "table of contents" list for the questions).

ID	Module	Question	Sequence
5852	4	none	mcccmcv
5852	4	overview	qccmccffmccvccmcvccmcacacmccvcvcmcvcccmcccmcmcvcvmcmccccffq
5852	4	1	qCqrCCqrr
5852	4	2	qmq
5852	4	3	qrr

Table 2: Sample Segmented Sequences

Our segmentation process reduces the 121,390 abstract events to about 18,500 segments, ranging in length from 1 to 150 with an average length of 7 events. The complete transformation process (for 200 student log files) takes 10 to 15 minutes.

3.2 General Pattern Search using MacSQEAL

To initiate a pattern search, MacSQEAL allows the researcher to specify:

- match criteria (e.g. match("^qr+$") and (module=4) and (question=4))
- items to be displayed for each match (e.g. "Line" or "count(C)")
- criteria for computing a frequency count for the matches (e.g. "count(C)")

The researcher specifies the match criteria using extended regular expressions – a general pattern matching a set of sequences. Perl regular expressions contain special characters that identify when elements or sequences can be selected from a set of choices (appear within [ ]), appear at the beginning (^) or end($) of a sequence, occur zero or once (?), zero or more times (*), one or more times (+), or a range of times ({3:6}). For example, the pattern `^qC+[qm]?r$` matches all sequences that begin (^) with q, are followed by 1 or more Cs, an optional q or m, and finally end ($) with an r.

Using regular expressions has several advantages: they permit the researcher to selectively ignore events without recoding. For example, the pattern `qm?cr` matches both `qmcr` and `qcr`, permitting the researcher to establish the `m` as not essential to the pattern. They also allow the researcher to specify a family of equivalent patterns. For example, the pattern `qC+r` matches all sequences with only one or more `C`s between `q` and `r` (`qCr, qCCr, qCCCr`, etc.). The pattern can determine which sequences are a match, but it can also be used to extract portions of the sequence to be tested or counted. For example, `^q([cCmaevq]*)r` matches everything from the initial `q` up to the first `r`. The portion of the expression in parentheses is saved in a special variable which can be referenced for displays or counts by the keyword `paren`. For example, when used in conjunction with `^q([cCmaevq]*)r`, the quantity `length(paren)` can be displayed in a histogram to show the lengths of investigation which precedes the initial attempt at answering a question. For a more comprehensive discussion of the extended regular expression capability of Perl, see [Schwartz 93].

A MacSQEAL query generates two kinds of output: a list of the items specified to display for matching lines, and the frequency count data. Both are in a tab-delimited format, which can be easily imported into graphing or statistics programs.

3.3 Examples

We have used MacSQEAL to extract two kinds of information: aggregate data (e.g. counts for a given pattern) and more complex queries. We will show one example of each.

Aggregate Data

One of the innovations of MacSQEAL is that aggregates can be explicitly tied to sequences. From the interviews, we know that some students are "question-driven": they read the question, and then use key words to pick content cards to visit, before they attempt to answer the question. We investigated this phenomenon for Question 4 in Acids & Bases [Fig. 1]. [Fig. 1a] shows the number of relevant content cards visited between reading the question and initial revision. However, a count of cards does not reveal how successful students are at identifying "relevant" cards. [Fig. 1b] displays the same query, with a different frequency count; this time showing the percentage of relevant cards in relation to total cards visited before initial response.

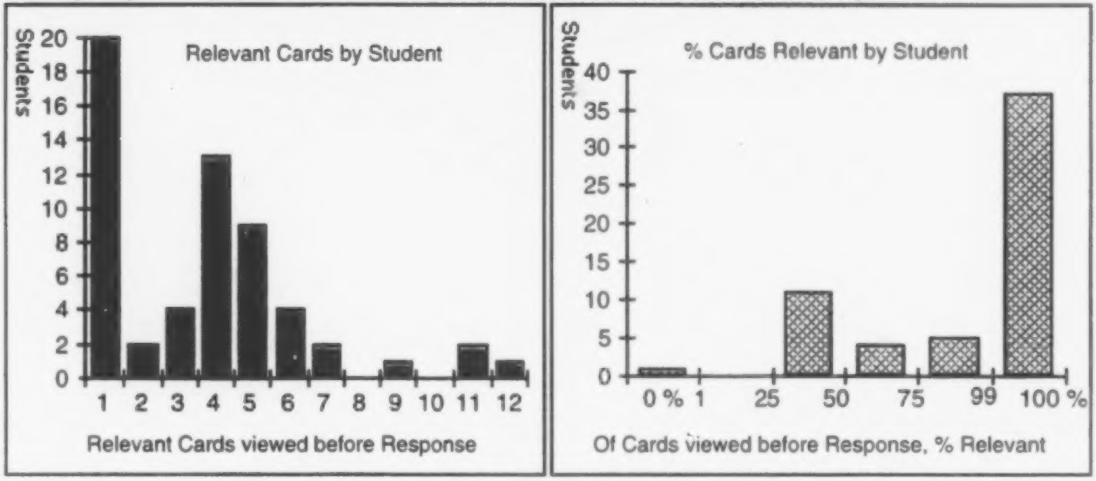

Figure 1: Question-Driven Students in the Acids & Bases module, Question 4

The query reveals 58 students with this "question-driven" pattern. The MacSQEAL query is as follows:

select: ^q([cCmaevq]+)r and (module=4) and (question=4)
frequency count: [Fig. 1a] countin(C, paren)
or [Fig. 1b] countin(C, paren) / (countin(C, paren)+countin(c, paren))

Complex Queries

In examining the responses for the Acids & Bases module, we were surprised by the number of students who revise (more than 40% on each question; ranging from 40% to almost 90%). We also identified a question (4) with an exceptionally high error rate, along with another question (6) with the second highest number of

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incorrect choices and revisions. We decided to examine patterns of use on these two questions in comparison to one another and to the other questions, to see how they might differ.

We use the following query:

select: r([mqaev]*[cC]+[mqaev]*)+r and (module=4) and ((question=4) or (question =6))
frequency count: module:question

The pattern "r([mqaev]*[cC]+[mqaev]*)+r" corresponds to "students who visit one or more content cards between revisions" – [mqaev]* means there is an optional (zero or more) visits to the question, the map, or other media. This query returns 75 students; 47 of these have the pattern only for question 4, 14 show the pattern only for question 6, and 14 show it for both questions. An interesting follow-up question is whether the 14 who exhibit the pattern for both questions differ on some important metric (such as previous experience in chemistry, or enrollment in the lab class) from those who use it for only one question, or not at all.

4 Discussion

4.1 Contributions

MacSQEAL facilitates sequence exploration by supporting fast ad-hoc queries over large data sets. By leveraging extended regular expression technology, the tool is able to match families of patterns as specified by the researcher. We integrate MacSQEAL and accompanying data transformation tools into a novel method for initial log file investigation.

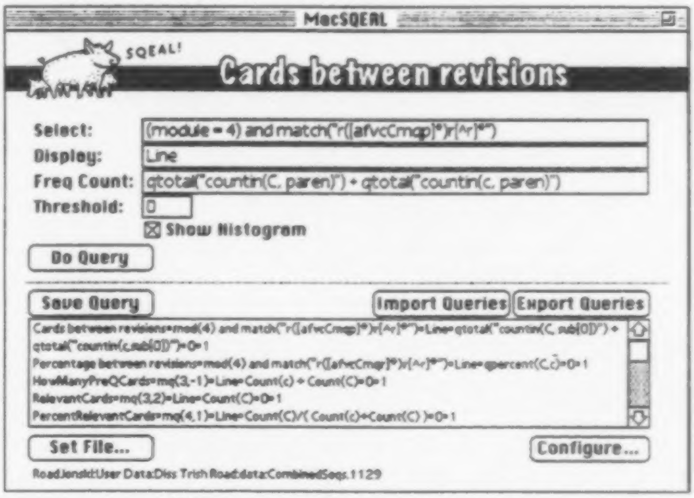
We believe that our method complements other approaches to log file analysis. Because of the speed of execution, it is possible to identify trends in the data, focus efforts on promising groups, and then apply other more formal, rigorous statistical techniques. The greatest value comes from a grounding in actual observations of, or interviews with students situated in their usage. This allows the researcher to understand some of the meaning behind events, and determine what may be important to investigate more fully.

4.2 Limitations

MacSQEAL is an exploration tool, not a discovery tool. Without hypotheses grounded in other analyses or data sources, MacSQEAL should not be relied upon for discovery. But for exploration – in our experience – it excels.

Because this work is both preliminary and exploratory, we do not know if regular expressions identify the most important natural groups. Maybe it is not as important that students match in their patterns of use as that they spend the same amount of relative time on one component, or that they exhibit similar misconceptions in their answers.

The process we describe is general, but — at least currently — the transformation tools are specific to our log files, and the format of the MacSQEAL input file is only informed by our data (we may need to add additional columns or features to handle data from other research groups).



Select: (module = 4) and match("r([afvcCmqp]*)r[^r]*")
Display: Line
Freq Count: qtotal("countin(C, paren)") + qtotal("countin(c, paren)")
Threshold: 0
☒ Show Histogram

Cards between revisions=mod(4) and match("r([afvcCmqp]*)r[^r]*")=Line=qtotal("countin(C, sub[0])") + qtotal("countin(c,sub[0])")=0=1
Percentage between revisions=mod(4) and match("r([afvcCmqr]*)r[^r]*")=Line=qpercent(C,c)=0=1
HowManyPreQCards=mq(3,-1)=Line=Count(c) + Count(C)=0=1
RelevantCards=mq(3,2)=Line=Count(C)=0=1
PercentRelevantCards=mq(4,1)=Line=Count(C)/(Count(c)+Count(C))=0=1

RoadJonski:User Data:Diss Trish Road:data:CombinedSeqs.1129

Figure 2: MacSQEAL query interface

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4.3 Future Work

MacSQEAL has a HyperCard front-end consisting of a fill-in form that is used to specify queries [Fig. 2]. In the future, we hope to add a more graphical interface, and to integrate the query mechanism more closely to graphing software (e.g. automatically generate the appropriate bar charts from frequency counts).

As part of the larger study examining student use of *Seeing Through Chemistry*, we are using MacSQEAL to extract overall patterns of use for each question for each student – these will then be part of a vector characterizing the student that will be used in a cluster analysis. More specifically, we will examine the relationship between prior chemistry knowledge, patterns of use in STC, and quality of inquiry question explanations.

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CyberSpace Cadets and Cadettes
Building Information Literacy with Young Children

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Abstract: The growing Internet accessibility for educational purposes has raised a range of issues that concern not only children's emotional safety and the beneficial use of limited resources but also their development of critical skills in searching, retrieving, and using information media. As interactive electronic media become more pervasive in children's school and home lives, it is especially important that even young children are developing these skills so that they can build a solid foundation for their later learning. As a case in point, this paper describes and discusses an educational intervention with over 200 elementary school children ranging from ages 6 to 13. During a five week period, students from six separate classrooms in the Los Angeles area built a collaborative World Wide Web directory. The resulting "SnapDragon" Web site is an annotated index by children for children . One goal of this intervention was to help children develop criteria of "information relevancy" as they were reviewing sites and writing their evaluations. A preliminary analysis of the evaluations indicates that many children placed a primacy on "visual relevancy" in contrast to "text relevancy" -- a result which reflects the issue that many web sites are not written in child-adequate language thus making it difficult especially for young children to gather pertinent collecting information about their world and culture. We furthermore discuss issues regarding children's information searching skills and collaborative models in classrooms with limited Internet access.

http://www.gseis.ucla.edu/SNAP/snapdragon.html

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Introduction

The rush to connect schools to the Internet is in full swing. In the report "America's Children & The Information SuperHighway" Lazarus & Lipper (1994) concluded that it is critical that all children have access to the Internet and furthermore that children's needs be given a high priority as technology strategies are developed and implemented. Netday'96, a non-profit initiative, aimed to connect twelve thousand California schools to the Internet in March 1996. While many schools have begun to give students Internet access, allow them to browse and search information, and to build their Web pages, it is still an open question in which ways Internet activities can effectively be used and integrated with other classroom learning.

The "SNAPdragon" project was created to investigate how children can interface with the Internet by asking them to build an annotated directory of Web sites for other children. The project's general goal was to build children's information literacy skills and to develop children's understanding of the value and relevancy of the information they gathered from various sites. For that purpose we asked them to write annotations to the sites they had visited.

Furthermore, we wanted to provide children with a context in which the search and retrieval of information would no longer be an isolated experience but connected to their classroom learning and to a larger social goal -- to share their insights with other children. Instead of keeping the annotated search results confined to individual classrooms, we implemented a collaborative index that could be accessed by other children through the World Wide Web. We also saw the construction of an information structure such as an index as another powerful way for children to gain better understanding of existing Web directories such as Yahoo, etc.

By observing students' efforts we could start to answer questions such as: Can children effectively use the search engines currently available? Can they find appropriate resources in a directed search? Can they evaluate and use the selected resources? The SNAPdragon project was a first step and only a few classrooms were involved in the preliminary research. We hope that the insights gained in this study will help teachers and researchers to design better learning environments in regard to classroom management, children's information search and evaluations, and students' motivation and interest.

Project Overview

For the implementation of the SNAPdragon project, we took advantage of an existing consortium of Los Angeles schools called The School Networking Action Project (SNAP). SNAP was started by the schools and Apple Computer's Learning Concepts Group. It was funded largely by Pacific Bell's CalREN (California Research and Education Network) initiative to afford California schools high speed networking capabilities. Pacific Bell and a series of other business and industry partners provided the participating schools with high speed phone lines, servers and Internet access. At the beginning of this project (January 1996) most of the schools (but not all their classrooms) had been connected to the Internet. But there had not been extensive use of this connectivity due to a series of technical obstacles.

To begin the Web project collaboration, a call went out to all the SNAP schools in November 1995, asking teachers and technology coordinators to send in applications indicating their interest. Schools were informed that the SNAPdragon project would run concurrently with an UCLA graduate seminar in which students would not only examine and discuss the educational benefits of telecommunication activities but would also be required to hold an internship in a local school. By January we had received over 20 applications. Teachers, UCLA graduate students and the seminar instructors met once in January to get to know each other and to select the sites. For this project, only six classrooms participated because we wanted to match each classroom with one UCLA graduate student or researcher. The classrooms were selected in such a fashion that at least one classroom from each SNAP school was represented. The following table provides an overview of the grade levels, number of students, number of computers with Internet access in each classroom (see Table 1).

TABLE 1: Overview of Participating SNAP Classrooms

School Name	Grade	Students	Internet-Enabled Classroom Computers	Search Topic	Curriculum Integration
Open Charter	3/4	64	1	City Building	yes
Westwood Charter	5	9	1	National Parks	no
Seeds UES	1/2	33	4	Airports/Iditarod	yes
Seeds UES	1/2	31	6	Ocean Animals	yes
Seeds UES	3/4	30	15	Black History/ Poetry	yes
Hawthorne School	6	29	1	Ancient Egypt	yes

Each classroom had a different physical setup, a different number of students, and a different search topic. In spite of all these differences, we hoped that the collaborative activity would provide enough "glue" to bring all the students and their teachers together. The following summaries provide an overview of how the SNAPdragon project was implemented at three of the sites. A complete reporting for each site can be found on the Web at http://www.gseis.ucla.edu/SNAP/report.html.

The Open Charter School is located in an ethnically and socioeconomically diverse section of the city of Los Angeles. The school has enjoyed a high degree of academic autonomy over the years because in the 1980s it received support from Apple Computer to install computers in every classroom. The SNAP classroom, a combined third and fourth grade class involved in this project, had two teachers, 64 children, and one Power Mac 6100 linked to the Internet via a 14.4 baud modem. We dialed into a server at UCLA for access.

The class was involved in a yearlong project of building a city of the future, called City Building Education(tm) (Nelson, 1984). Since the children were already organized into various commissions for building the city, we structured the Internet search sessions around the already formulated commission schedules and themes.

On most Mondays and Fridays in February 1996, two hours of the school day were set aside for Internet time. We managed the Internet searches by having four of the commissions take half-hour turns sitting in a circle of chairs around the computer. The search session was structured by the researcher, who came to class equipped with URL address lists and then looked up the Web sites as the children observed. This strategy was adopted because it seemed the most efficient way to describe how the Web worked to large groups of children. As the sessions evolved, the students took turns working different "jobs" related to the search. There was a "mouse master," a "reader," and a "scribe" to record each commission's annotations. These jobs were rotated for each Web page search.

Internet search sessions were focused on critiquing the Web pages. These sessions challenged students to move beyond simple "I like it" and "I don't like it" answers and toward offering evidence for their opinions.

The sessions also gave students a chance to practice reading and writing. Issues of vocabulary came up repeatedly because many Web sites included difficult words.

The Web searching process revealed a dearth of "child-friendly" sites, particularly concerning subjects considered too technical for kids, like new transportation technology. We found that including the word "kids" in searches usually turned up more colorful, interactive sites in plain English. By far, these were the children's favorites. In total, the children received 9.5 hours of Internet time. The preparation time outside of the lesson was about equal to in-class time, divided equally between searching for good sites and troubleshooting technical problems.

The highlights of our findings were that: 1. children prefer Web sites with high visual content and short, simple textual content; 2. children are eager to create their own work and put it on the Internet; 3. children want to use the Internet for recreation, long-distance communication and class project research; 4. children are inspired to talk about their social views and surroundings when they view Internet sites featuring children's artwork and photographs from other places; 5. children would like to see more animation and interactivity on the Internet; 6. children have a low tolerance for long download times; and 7. children require support in their search process, particularly with scanning text and using hypertext links.

The Westwood Charter School is a public Los Angeles City School located in a middle class, mainly single family dwelling neighborhood. Nine students from a fifth grade classroom participated. The ethnically diverse group consisted of 3 girls and 6 boys all of whom were ten or eleven years old. The children were comfortable using computers and had adequate typing and spelling skills. Many of them had access to computers at home. The children's teacher encouraged the use of technology in the classroom and was herself quite knowledgeable. The school was fortunate to also have a very knowledgeable and enthusiastic technology coordinator who had previously worked in the software industry.

The children met for two hours once a week for six weeks. Generally the first part of each session was used for discussion, mini-lessons and problem solving. Since there was only one computer available, the children were divided into self selected collaborative groups of three. The children selected the topic "National Parks" and the three groups took turns searching the net for sites containing information about National Parks.

In the first two sessions the children explored the net. They learned how to navigate, perform searches, use bookmarks, visit sites and use hot buttons. As the children became more skilled, they were exposed to additional search techniques and helped to perform more directed searching.

The children preferred sites with pictures and colorful graphics. Sites composed of only text or with more than 1 or 2 pages were left unexplored and in general children rarely spent more than a few minutes at any one site. The most popular site was the Hawaii Volcanoes National Park site. It contained a map of the caldera superimposed over a photographic image of the area. The colors were vivid and most of the names and locations on the map were hot buttons that linked the visitor to a brief description of the selected feature or area. These hot button encouraged the children to explore at a greater depth than if the information had been contained in a single site. While the children were enthusiastic about visiting Internet sites, they resisted writing annotations for the directory. Only after they saw other children's contributions were they willing to put effort into constructing the annotations.

Limited observation of these fifth graders suggests that children, age 10 and above, are capable of finding resources on the net. Their typing, spelling, vocabulary, and Boolean logic skills do come into play and can limit their ability to find appropriate resources. However, with direction, they are able to formulate search arguments, narrow or broaden a search depending on the previous search results; and they are capable of comprehending hierarchies when they have adequate base knowledge. Just as in the library, where the children often need the assistance of a librarian to find the materials they need (and so do most adults), children searching the net will also need an intermediary to help them track down appropriate sites. The level of comprehension and interest would suggest that the Internet may be a valuable resource for children.

The primary classroom of Mr. Raul Alarcon at Corinne Seeds University Elementary School has 31 bilingual (English/Spanish) children age six to eight. This classroom contains six networked Macintosh LCIIs which have direct Internet access from UCLA. Netscape's Navigator (version 1.1) Web browser is installed on each computer. The children spent a total of 10 sessions using the World Wide Web. In addition to the researcher and the classroom teacher, a school librarian was also present and available for help at each session. Each of the sessions was approximately 30 minutes long. Some children casually used the computers in the morning before school started or at other free times throughout the week. A few children also had computers available to them at home.

The children were studying "ocean life" over the course of the semester. Prior to the introduction and use of the Internet, the class discussed sea life, read about fish and ocean mammals, did some library research, and collected appropriate books to have available in the classroom throughout the duration of the project. Each student selected one ocean fish or mammal to learn more about. The children planned to use the World Wide Web to find more information for their sea animal research reports.

The children spent several sessions exploring a list of Web sites the adults had found in advance to determine each site's relevance to their particular ocean animal. The children were very eager to share their findings with one another. If one child found an interesting site which did not contain information on the animal they were researching, but thought the material would be of interest to a friend, they would tell the other child. They also printed and exchanged relevant pages with one another. Some children had more success than others in finding information depending on what fish or mammal they picked. There was far more age appropriate information on dolphins, sharks and whales than for seahorses, star fish or eels for example.

The children learned that the information they found on the Web could be submitted by other adults or by children and that the information came from all around the world. As Mya (age 7) and I waited for one Web page to download I asked her what she thought about waiting. She said, "Well, since there's just one world -- its gotta be coming from somewhere in this world, but it could be coming from another city or country."

We wanted to get the children to think critically about the information or perhaps the misinformation they might be receiving. As with books and other "authoritative" media, the children were quick to assume everything they found about their sea animal on the Internet was correct, just because it was there. Many of the information providers may not have accurate information or the ability to communicate it effectively to children, however.

The children's annotations of the Web sites played a secondary role in this classroom project. The children did not begin to evaluate the sites until the third week into the study. Because of the children's young age we could not ask them to write up annotations on their own. I sat with the children one at a time to get their selections for the "best site" relevant to their sea animal. In general, the children had difficulty articulating why they picked one site above the others. The resounding reason was that "it had lots of information", or "it had good information".

The children were generally highly accepting of all of the Web sites and believed they were all helpful and interesting. Their favorite selections were generally Web pages created by other children.

When the SNAPdragon site became "live" the children were delighted to see their own comments posted on the Web. It gave them a great sense of pride to know that children and adults from around the world could read their comments and also benefit the information provided in their "favorite" sites.

Summary

In March 1996, the SNAPdragon project was brought to a temporary completion. We concluded our intervention with another meeting in March to which all the participating teachers, even some students and other interested researchers and visitors came to share their experiences. While the SNAPdragon project was not a systematic study of different classroom settings and students' information literacy skills, we nevertheless gathered some valuable insights for future Internet activities.

Internet Access. As noted in many policy reports and discussions, access to the Internet is an important issue, if only for the limited resources of computers, phone lines and wiring. While providing all students with computers might not be possible, we found that working with even one Internet-accessible computer turned out to be feasible given certain classroom arrangements. In one case (Open School) we took advantage of existing team structures, i.e., the different city building commissions, and used the commissions and their topical interests to direct the Internet searches. In another case (Hawthorne School), we adopted a "tutoring" model in which the most Internet-experienced students became the tutors to teams of their classmates guiding them along their searches. In other classrooms, we built teams of students that searched together. In our effort to integrate the SNAPdragon activity with existing classroom activities, we found that (with some exceptions) these collaborative arrangements worked well and amplified students' learning of how to work together.

In our classroom observations we found considerable differences between those students who had opportunities at home or other places to familiarize themselves with computers and different tools and those for who it was a first experience. These differences appeared as early as in the primary elementary grades with students of ages 6 and 7. Expertise in manipulating the mouse, identifying interface elements such as buttons and menus, and finding keys on the keyboard varied among students.

We also were hesitant at first about the inclusion of primary elementary school students in the SNAPdragon activity. It was unclear how these young students would be able to use the Web for their learning purposes because of their beginning writing and reading experience. One situation concerned the typing of the long string of HTML addresses. The children often typed the URLs incorrectly and were prevented from connecting to their desired Web site. The typing activity also took valuable time, leaving less time for the children to spend with the content material they required for their reports. Some of us felt it was a waste of time for the children to labor over the cumbersome, meaningless strings of letters and symbols. Our recommendation is to have children use bookmarks for either directing their searches or for marking "valuable" sites.

Information Searching. One of the main goals of the SNAPdragon project was to provide a context for children to exercise their information searching activities for a larger social goal-to build a collaborative annotated Web directory for other children. While the younger students were not engaged directly in searching sites on the Web, the older elementary school students conducted some searches and used different available Internet search engines. In initial efforts, students simply put in terms such as "National Parks" and expected the results to be their end of their searches. We found that asking students to pick different search engines, to input the same terms, and to compare and to discuss the different search findings resulted in a better understanding of search functionality. These sessions seemed to help best when introduced after students had experienced some frustrating search results. As some previous research on students' information search abilities has found, students have difficulty developing extended search strategies as well as developing criteria for satisfactory end results.

Information Selection. Selecting good sites was also difficult for students. Titles and descriptions returned by search engines were sometimes misleading and difficult for the children to evaluate. After some discussion, students improved their ability to identify sales and marketing sites versus informational sites. This problem was also compounded by their reluctance to read or scan the list of results. It appeared that only titles were used to decide which site to visit. Since the system was often slow, picking the wrong site precluded visiting additional sites.

The Web searching process revealed a dearth of "child-friendly" sites. By far these were the students' favorites, but even they didn't really measure up to students' high standards. The students demanded higher production values: quality audio, video and heightened interactivity. The attractiveness for the later aspect showed itself in a site which students found in their searches about "ancient Egypt": they could submit their name to the site and have it returned in hieroglyphs. This was by far one of the most popular sites. Sites without graphics or pictures were almost always deemed boring and uninteresting and text-only sites were not explored. It was from reading the evaluations written by the students that it became evident that students placed a primacy on visual information on the Web sites and had more difficulties in evaluating the text-based content.

Information Evaluation. Creating annotations for this index, dubbed the SNAPdragon page, introduced students to the practice of critiquing other people's work. In critique sessions, students were challenged to move beyond the simple "I like it" or "I don't like it" statements and offering evidence of their opinions. Their initial annotations were for the most part poor and it required a significant effort to persuade them to actually evaluate the site. They did not see the point or value of writing annotations. Two factors changed this. Often the researcher or teacher reminded students that their efforts would be seen on the Web and that they were representing their school. The second factor had a greater effect. When the students were actually able to visit the SNAPdragon site and read other children's write ups the task became important. In one case, a student wanted to write, "this site sucks"; only after he became aware that other students from all over the world would be able to read this annotation, he decided to expand his commentary. These sessions also gave students a chance to practice reading and writing. Issues of vocabulary came up repeatedly because many Web sites included difficult words.

Conclusions

In general, students' interest in Internet activities was high. The students, of course, were enthusiastic since "surfing the net" is the cool thing to do. They all expected that they would use the Internet in the future probably from home and several students talked about their parents giving them access to the Internet. For future activities, we recommend to build on children's interest in the Internet by providing them with opportunities to represent themselves to this community. SNAPdragon became one way to do so. We would probably start out by asking children to write something about themselves, their class or school and use it as a first submission to a site. Having an "Internet" identity seems to be of great value to students.

While the project in its first installment was initiated and organized by adults, we think that having the students handle all aspects, from creating the site and collecting annotations to indexing the entries will prove to be the best learning experience. In fact, one of the most valuable learning experiences for the members of the university course appeared when we were confronted with the task of categorizing the first SNAPdragon submissions. Due to the different search areas, content ranged from national parks to transportation and poetry. We had extensive debates which category names to choose and how to index entries-tasks faced by any professional information specialist. By default of any better solution, we adopted the Dewey classification system. While the categorization of musical instruments, animals and plants is a common activity in elementary classrooms, students usually do not deal with the wide range of issues that appeared in SNAPdragon indexing, or for that matter with any directory. In retrospect we wished that the students had had this opportunity. Becoming information literate, or better, fluent, means more than knowing how to search for the right information. It means understanding all of the issues ranging from the making, to finding and using of information.

The Nature of Conceptual Change in Astronomical Phenomena in the PICCO Environment

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Abstract: This article will describe conceptual change in children's conceptual models of astronomical phenomena when children explored the phenomenon using a pictorial computer-based simulation, PICCO. The exploration of the phenomenon by children was based on children's own interest, and occurred spontaneously and independently without any adult involvement. The selected phenomenon for PICCO was the variations of sunlight and heat of the sun as experienced on Earth related to the positions of the Earth and sun in space. The children had no formal instruction before or during their exploration process. The children taking part were Finnish first-graders who were about seven years old. Conceptual change in the children's conceptual models seemed to occur in the direction of the currently accepted scientific knowledge. Conceptual change has been compared with Thagard's taxonomy of kinds of epistemic change and Vosniadou's research results of conceptual development in astronomy.

Introduction

In this article, conceptual change in astronomical phenomena will be examined in the PICCO environment. PICCO is a pictorial computer-based simulation which has been designed and constructed for the author's investigation. Conceptual change has been studied in a child's conceptual model, concerning a selected natural phenomenon, when a child is exploring the natural phenomenon by using PICCO. In this investigation a conceptual model is seen as a mental construct, which is developing during a child's cognitive action. A child's cognitive action like perception, remembering and thinking processes, as well as activities connected with them, are primary processes in the developing of a child's conceptual model concerning a given natural phenomenon. Correspondingly, the conceptual model of a given natural phenomenon forms a basis for a child's cognitive activities concerning the phenomenon in question. By means of a conceptual model through visual images it is possible, for example, to examine a phenomenon, its objects and their qualities and spatial and temporal relations, both events taking place within the phenomenon, and also to follow the sequences of the events. In addition, a conceptual model makes it possible to explain and predict a phenomenon. [Compare Nickerson, Perkins, Smith 1985.] The more developed and integrated the conceptual model of a phenomenon, the better basis it gives to cognitive activities concerning the phenomenon in question.

This paper concentrates on the nature of conceptual change in the children's conceptual models, which occurred when the children were exploring the phenomenon by using PICCO. In the examination, the subject of the interest has especially concerned the following questions: How a child's conceptual model concerning the selected phenomenon constructs, when a child can spontaneously and independently, from the basis of his or her own interest, explore the phenomenon using the PICCO program. Further, how and in which direction conceptual change occurs in the multimedia environment and in this case, especially in the PICCO environment. These afore-mentioned questions are important and of significant interest. This is because previous research concerning the conceptual development in astronomy has suggested that children proceed during their knowledge acquisition towards the scientific knowledge through many kinds of misconceptions. In addition, the abandonment of the misconceptions has proved to be very difficult.

The children taking part in the present research were Finnish first-graders who were about seven years old. They had no formal instruction before or during their exploration process of this natural phenomenon at school. Immediately after the research period, during the school term this topic was also dealt with. During the research period, the children had the possibility of exploring the phenomenon by using the pictorial computer-based simulation over four week period in a day care centre after school. In the research group there were eleven children.

The following chapter will briefly describe the pictorial computer-based simulation, PICCO. Afterwards the nature of conceptual change in the children's conceptual models will be examined. After this, conceptual change in the children's conceptual models in relation to conceptual development in astronomy will be compared.

Description of the Pictorial Computer-Based Simulation - PICCO

This chapter briefly describes the pictorial computer-based simulation, PICCO. The selected natural phenomenon for the pictorial computer simulation was the variations of sunlight and heat of the sun as experienced on Earth related to the positions of the Earth and sun in space. In the simulation, it is possible to explore the variations of sunlight and heat of the sun and their effects on the Earth in a natural environment and the origin of these phenomena from the basis of the interconnections and positions of the Earth and sun in space. The simulation concentrates on phenomena which are close to everyday experiences of children, such as day and night, seasons, changes in the life of plants and birds etc. The simulation program has been implemented in such a way that the knowledge structure and theory of the phenomenon are based on events appearing together with the phenomenon in question, and these events are illustrated. In the simulation, all events and necessary elements are represented as pictures and familiar symbols. On the Earth level, the pictorial simulation represents the surrounding world, its phenomena and objects in a very natural and realistic way. In exploring the phenomenon on the space level, the interrelations of the Earth and sun are represented with the help of an analogous model. The selected place on Earth from where the phenomenon has been modelled and simulated for a computer is the suburb of Lentävänniemi in Tampere, in Finland.

The exploration of the phenomenon starts in Lentävänniemi on 1st January at midnight. On a big screen a dark, snowy, winter landscape in a southerly direction is seen at that moment. The exploration of the phenomenon can be continued by using icon pictures under the picture of the landscape, for example, a clock, a pictorial calendar, a picture with different points of the compass and a space shuttle. The exploration of the phenomenon can be continued in many ways; hour by hour, day by day, month by month, at different points of the compass and so on. At any moment it is possible to take a space shuttle and to look at the interrelations and positions of the Earth and sun on the space level. On the space level it is also possible to explore the interrelations and positions of the Earth and sun by using icon pictures which show the time in the same way as on the Earth level. At any moment, it is possible to choose how to continue exploring. Exploring can proceed at any moment using the existing alternatives. Two displays of the screen can be seen as examples in Figures 1 and 2. The pictures were drawn by Aila Penttiä.

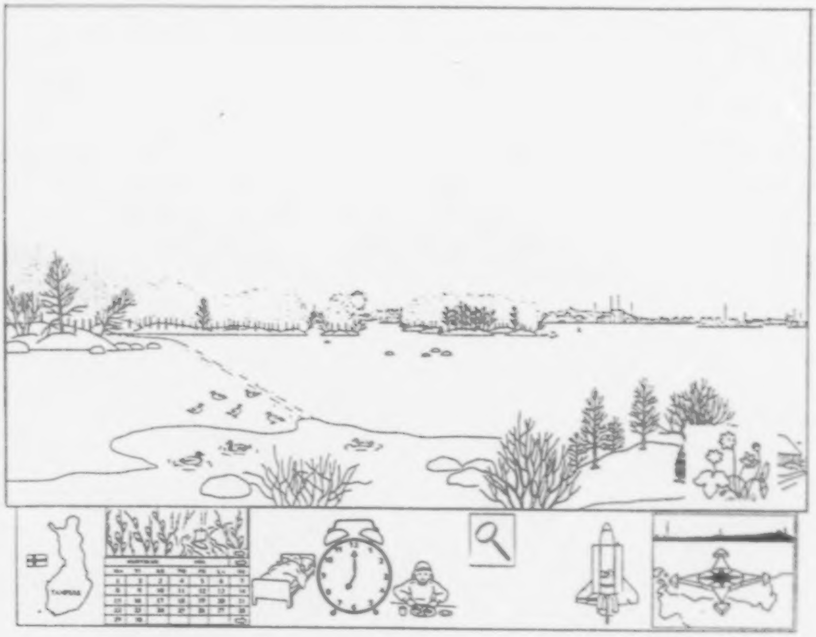

Figure 1. 1 April at 7 o'clock in the morning toward the east a hepatica being enlarged

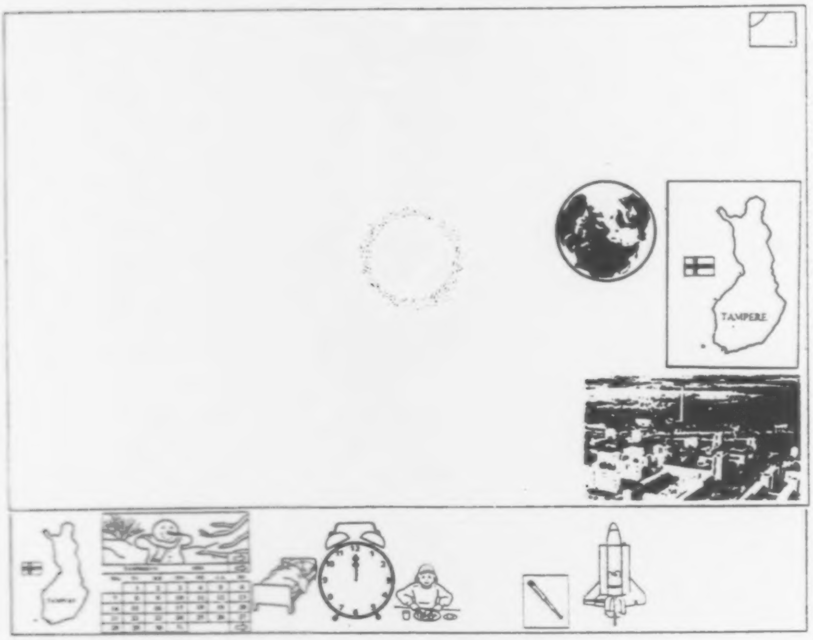

Figure 2. 1 January at 12 o'clock, at the space level with a bigger earth, the map of Finland and the aerial photo of Tampere

When exploring on the space level, the Earth, rotating around its axis and revolving around the sun on its elliptic orbit, appears on the screen. When exploring the phenomenon on the Earth level, the following may appear on the screen: the changes in dark and light during the day with an accuracy of one hour, the sun's positions in the sky every hour, the place and time of the sunrise and the sunset every day all year round, typical plants, birds and animals according to seasons and so on. With the help of the icon pictures, binoculars, a magnifying glass and microscope, it is possible to explore flowers, trees, leaves, insects, birds, spores, animals and so on in more detail. On the screen, a selected object is enlarged. On the space level, with the help of a telescope, it is possible to enlarge the earth so that, for example, Finland is seen more clearly. From this picture of the Earth, it is possible to continue further and to see the map of Finland, and finally an aerial view of Tampere. In the simulation, it is also possible to explore the relative size of the Earth and sun and to get an idea of the distance between them. The position of the Earth in the whole solar system can also be seen on the screen. The pictorial computer simulation is constructed so that it is very easy to use and it does not presuppose an ability to read or write. A pictorial computer simulation [Kangassalo 1991] is described in detail in the articles by Kangassalo [Kangassalo 1992, 1994, 1996].

The Nature of Conceptual Change

Before and after the exploration of the natural phenomenon using PICCO, the children's conceptual models were elicited by using specifically designed procedures for this investigation. The eliciting of a conceptual model was achieved using procedures aimed at stimulating a recollection of the natural phenomenon in question. A child modelled the natural phenomenon from the basis of recollections and images through action, pictorially and verbally using different tasks. The modelling took place by showing, drawing, modelling and explaining. The phenomenon forms the wholeness which contains many, integrated phenomena and their interconnections. The

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main interest in this research was to study a child's conceptual model of the selected phenomenon, emphasizing relations and their changes in a child's conceptual models concerning the phenomenon in question. Regarding the natural phenomenon in question, attention was paid to the variations of sunlight and heat of the sun on the Earth, the interconnections of the Earth and sun in space, and interrelations of phenomena on the Earth and in space. In addition, attention was paid to the size, form and distance between the Earth and sun.

Before the use of the simulation the children's conceptual models were at very different levels. Some children's conceptual models of the phenomenon were quite undeveloped, and some others' were well developed. Only some children's conceptual models contained a clear misconception. During the use of the simulation in the children's conceptual models some changes occurred. The most significant change was that the interconnections of different phenomena and entities began to be constructed and the construction seemed to follow the currently accepted scientific knowledge. Concerning the natural phenomenon in question the main direction of construction by children tends to be as follows:

1. The Earth begins to revolve around the sun.
2. Seasons are organized in the everyday world and are connected to the positions of the Earth and sun in space.
3. The alternation of darkness and lightness on Earth is seen to have resulted from the turning or revolving of the Earth in it's orbit.
4. The alternation of darkness and lightness and the succession of seasons, has been seen to have resulted from the rotation of the Earth around its axis once every 24 hours while the Earth is revolving around the sun, a circuit around the sun taking place once a year.
5. Before the use of the simulation, the sun was revolving around the Earth in three children's conceptual models but, however, after using the simulation, in two out of the three conceptual models the sun no longer revolved around the Earth.

Next, the nature of conceptual change will be examined according to the afore-mentioned direction of construction in children's conceptual models, concerning the phenomenon in question. In examining changes in children's conceptual models, the most significant change concerned the interconnections of the Earth and sun. The Earth began to revolve around the sun in those children's (6/11) conceptual models where, before the use of PICCO, the spherical Earth was either motionless or it turned, spinned or swayed in one place in relation to the spherical sun or where the examination of the phenomenon occurred only on the Earth level. The revolving of the Earth around the sun was expressed mostly with the help of showing clay models. In some cases the children used some words. The changes in question, were changes in the spatial interrelations of the Earth and sun. The change brought something new into conceptual models leading towards the direction of scientific knowledge and that is why it is possible to say that the nature of conceptual change in these cases was additional. In one case, the revolving of the Earth around the sun indicated also the change in the examination level of the phenomenon in question.

Next, the organizing of order, continuity and regularities of seasons on the Earth level and their connection with the position of the Earth and sun on the space level will be examined. These connections and relations seemed to form the following phase in the construction of conceptual models by using PICCO. When the succession of seasons, organized on the Earth level during the use of PICCO or was organized before it, connections with the positions of the Earth and sun in space began to take shape. Connections varied from weak connections (3/11) to developed connections (2/11). In the weak connections, the movement of the Earth around the sun had been seen to be in some connection with the succession of seasons on the Earth level. In the developed connections, the connections of the Earth and sun could be seen to be in relation to the phenomena on the Earth, almost according to the current scientific knowledge of the interconnections of the Earth and sun. In both two cases, the children's conceptual models constructed, were leading towards the acquisition of scientific knowledge, and changes were additional to the existing conceptual models.

The next phase in the construction of children's conceptual models of the phenomenon by using PICCO, concerned the connections of the alternation of light and dark on Earth with the positions of the Earth and sun in space. The above-mentioned two children (2/11), who could connect, in their conceptual models, the succession of seasons on Earth with the relationship between the Earth and sun in space quite well, tried to then connect the alternation of light and dark on Earth with the position of the Earth and sun in space. These two afore-mentioned children went about the question in different ways. In one case, after the use of PICCO, the alternation of light and dark had been seen to be connected to the revolving of the Earth around the sun. In the second case, after the use of PICCO, the alternation of light and dark on Earth was seen to be connected with the turning of the Earth on the same place on Earth's orbit. In these children's models, the alternation of light and dark was not connected with the succession of seasons in the position of the Earth and sun on the space level. They were modelled separately. Conceptual change in these cases were in nature reorganization. In the first case, reorganization occurred so that old connections were replaced with new incorrect connections and in the second case, old incorrect connections were replaced with new positive connections. Changes in both cases occurred in the spatial relations between the Earth and sun.

The next phase, in the construction of conceptual models using PICCO, seemed to occur so that the alternation of light and dark and the succession of seasons on the Earth level was connected on the space level in the interconnections of the Earth and sun. This reconciliation took place in one child's (1/11) conceptual model. In his model, before the use of PICCO, the alternation of light and dark had been seen to be a result of the revolving of the Earth around the sun. In addition, the succession of seasons in the interconnections of the Earth and sun was modelled separately. In this case, conceptual change was in nature reorganization where old connections were replaced by new connections and the result was a progression towards the direction of scientific knowledge.

Changes in the interconnections of the Earth and sun also occurred in situations where, at the beginning, before the use of PICCO, the sun revolved around the Earth. In two out three of these cases, after the use of PICCO, the sun no longer revolved around the Earth. In the first case, both the sun and the Earth remained motionless. In the other case, the sun turned in one place in relation to the Earth, causing the variation of day and night and the succession of seasons on Earth. In these cases, the changes concern changes in the spatial interrelations between the Earth and sun. The old spatial interrelations between the Earth and sun break and fade away, but in the other case some incorrect relations occurred in the child's model. In the former case, conceptual change is by nature the deletion of information and in the latter case, both the deletion and addition of information.

The afore-mentioned examination has concentrated on the nature of conceptual change in children's conceptual models. Next, the summary concerning the conceptual change in the children's conceptual models of the selected natural phenomenon, in the PICCO environment is given: The point of view of the phenomenon changes, and addition, deletion and reorganization occur in conceptual models. Reorganization can be seen to further divide the replacement of existing relations with new relations, the joining together of separate relations or the finding of new relations. When examining children's conceptual models and their construction on the whole, it is possible to ascertain that the level of abstraction in children's conceptual models has increased as well. The kinds of conceptual change in this research can be recognized as are seen in Figure 3, although in the children's conceptual models the kinds of conceptual change are interwoven.

In *the taxonomy of kinds of epistemic change*, Thagard [Thagard 1992, 37] separates the following conceptual change: addition, deletion, reorganization and hierarchy redefinition. Reorganization is divided into simple and revisionary, and simple is further divided into differentiation, coalescence and decomposition. In this research, reorganization, where separate relations or parts join together, could be comparable with simple reorganization in Thagard's taxonomy. Thagard's reorganization by the principle of revisionary, can possibly be compared to reorganization in this research where the replacement of existing relations occur within new relations. Further, some features of hierarchy redefinition of Thagard's taxonomy can possibly be seen in this research as a change which is called the change of the point of view.

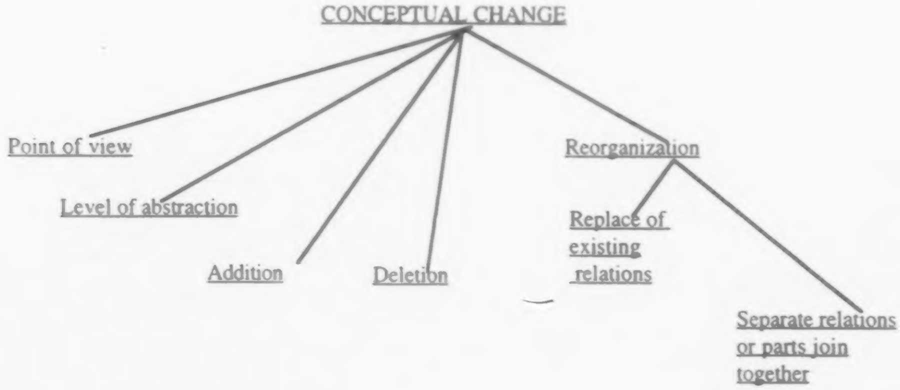

Figure 3. Kinds of conceptual change in this research

Conceptual Change Using PICCO in Relation to Conceptual Development in Astronomy

In this chapter, conceptual change in the astronomical phenomena between Vosniadou and her colleagues' research results and the present research results will be examined. From the basis of her research results, Vosniadou [Vosniadou 1991, 169] argues that children start their knowledge acquisition in astronomy by constructing an intuitive cosmological model of a flat, stationary Earth in a geocentric solar system, in which the sun and the moon move in an up/down direction and cause the day/night cycle. Eventually, this intuitive model changes to that of a spherical Earth, which rotates around its axis and revolves around the sun in a heliocentric solar system, in which the day/night cycle is caused by the axis rotation of the Earth and not by the movement of the sun and the moon. The process of restructuring intuitive knowledge is slow and is characterized by the emergence of various misconceptions of scientific explanations. [Vosniadou 1991, 1994].

When examining conceptual change in the present study, the main observation was that the development of conceptual models by children when using PICCO, occurred mainly in the direction of current scientific knowledge. Whereas, according to Vosniadou and her colleagues' research results, conceptual change in astronomical entities is seen to go through further phases where misconceptions are probable when children try to reconcile scientific knowledge with their initial models.

Although the comparison between Vosniadou and her colleagues' research results [Vosniadou and Brewer 1992, 1994] and the results of the present study has to carefully be made, because of the differences in the study of the entities and methodology, the differences in the results show that conceptual change in astronomical phenomena can proceed in a different way when children can explore the phenomenon in question, by using a computer-based simulation of that phenomenon. In this research, the scope of the construction of the children's conceptual models varied greatly but the direction in the construction proceeded towards the current scientific knowledge. In addition, the time, which the children used for exploring the phenomenon by using PICCO was on average only 60 minutes.

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Using Performance Data to Define Individual Learning Plans

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Abstract: This paper looks at the underlying model and interface of a Learning Guide that is part of a computer-based performance support and training system. The model uses performance data and courseware completion data to determine system confidence in a user's completion of learning objectives. Based on this confidence, the Learning Guide presents a prioritized list of relevant computer-based training components. The user is given considerable flexibility in their use of the Learning Guide and is empowered to access content that is relevant to their specific needs.

Introduction

We are working on a large project that provides computer-based performance support and training in a large financial institution [Karrer & Lukens 1997]. The primary business objective of this project is to increase customer loyalty. To achieve this goal, we have designed systems and tools that support customer advisors in effectively performing their day-to-day activities.

This project has a variety of interesting aspects in that it combines data mining, survey research, customer interaction software and interactive multimedia performance support and training. Data mining provides input that can flag customers that have some likelihood of defection. Furthermore, the rules provided by the data mining system are tied directly to suggested performance in order to provide support for dealing with the root causes of the defection. Additionally, survey research provides significant input about specific issues that have been found to be important to customers that are within the same segment. Like the results of the data mining, this information can be used to drive specific performance support suggestions.

This paper concentrates on a particular piece of this system, the Learning Guide. This guide uses sales data, customer contact data, sales goals data, planning data, and courseware completion data to drive individualized learning plans. In this system, learning plans are a prioritized list of relevant computer-based training components that are appropriate for this user. The Learning Guide is a tool that presents the learning plan to the user and provides considerable user freedom in controlling the presentation of the plan.

In this paper, I will first introduce the overall system and describe the kinds of computer-based training components provided by the system. Next, I will discuss the Learning Guide interface giving an example of its use. I will then discuss the underlying model in more detail. Finally, I will conclude with a discussion of the status of this project and future work.

PS SMART™

PS SMART™ (Performance Support: Strategic Marketing and Retention Technologies) provides computer-based performance support and training that is dynamically customized for individual needs in order to elicit employee behavior that ultimately inspires customer loyalty. The key areas of this system are tools, knowledge base, interactive presentations, simulations, on-line tests and support functions, see Figure 1.

The tools consist of a variety of applications aimed at identifying customers that should be contacted, analyzing these customers, and supporting the advisor in these activities. Customers are identified for contact for any of a variety of reasons including customer care, inconclusive prior contact, early warning indicators of loyalty gaps, cross-selling opportunities, product gap analysis, etc. Customers are analyzed by starting with an overview of the customer that includes important red flags (signals), sales opportunities, and customer segment information and drilling down through more detailed information using hypertext links. Analysis tools also help the advisor plan for customer sales contacts, providing helpful suggestions for questions to understand client needs, how to present specific products relative to the client's particular data, and to identify additional information that should be uncovered through the contact and other aspects of effective relationship building.

The organizer and reminder tools assist the advisor in scheduling appointments and is tightly integrated with the customer analysis tool so that customer data can be easily obtained with a click of the mouse. The organizer and reminder will also contain important contact and follow-up steps determined by the contact preparation and reporting tools. The sales goal and reporting tools support advisors and their sales managers in establishing and tracking sales goals over time. Several interesting pieces of data can be naturally collected by other tools such as potential customers, high-potential customers, contacts scheduled, products offered, orders fulfilled and follow-ups made. This information, coupled with the support tools, training system and standard performance benchmarks, serves as an effective basis for personal management of sales goals.

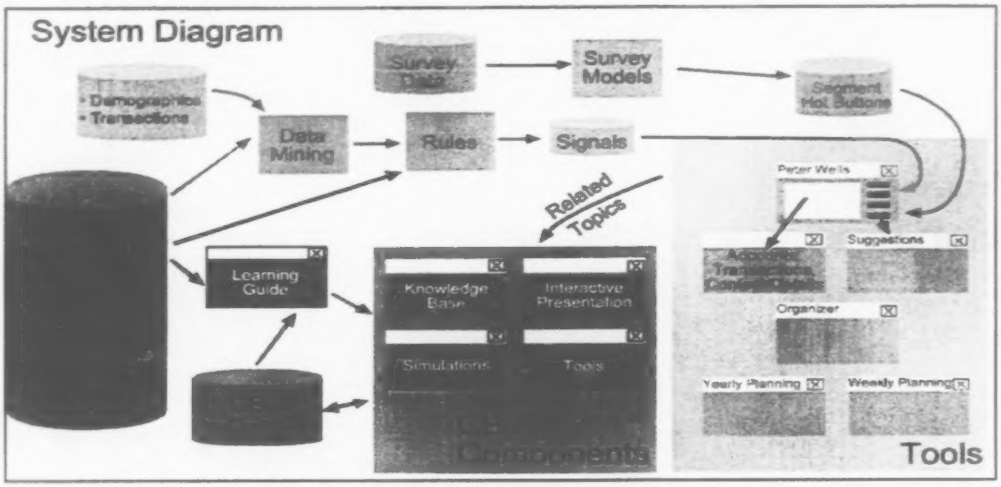

Figure 1 - PS SMART System

The knowledge base is a hypermedia reference system containing information on all aspects of the business including products, customer segments, sales styles and techniques, best practices, presentation styles, etc. It is designed for quick access of relevant information while using the tools and training. This tool is flexible and can be easily updated and expanded so that important knowledge is accessible with a click of the mouse. This tool also contains certain pages that are interactive presentations. These presentations include various user interactions or inputs to emphasize specific content points. For example, we provide a risk versus reward calculator that can show potential profit and loss given certain conditions. These presentations, coupled with video and audio segments, help to make this an effective learning vehicle.

The reality-based sales simulations provide the opportunity to play the part of an advisor throughout a sales process. Advisors can decide the best way to greet a customer, respond to a customer complaint, handle an objection, even close the sale. Users do this by making choices that drive a video-based storyline and by using tools to get customer information in the same way they are used in the real system. This virtual interaction environment is good because users can make mistakes, see the results of their decisions, and sharpen their skills before stepping into an actual branch office situation with real customers.

On-line testing exercises a broader range of knowledge than is generally possible in simulations. As in the simulations, the use of tools and best practice behavior are central to the content of the tests.

In addition to the primary tools and CBT components described above, users can also access a variety of other support functionality including communications, feedback, and search functionality. The search complements the Learning Guide, allowing the user to search for information across CBT components, i.e.,

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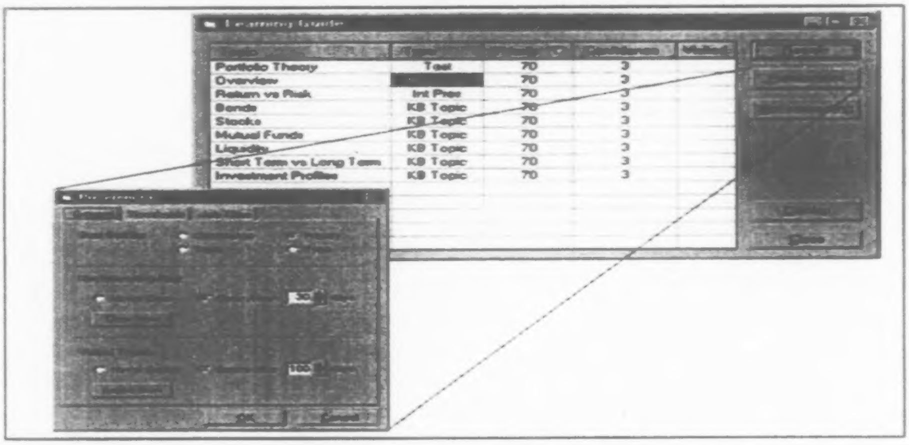
simulations, tests, knowledge base and interactive presentations. Given this brief description of the system, we are now prepared to look at the Learning Guide in more detail.

Learning Guide Interface

In order to understand the Learning Guide, it is first important to recognize our main goal. This goal is to provide a list of relevant topics allowing the user to find interesting content, but not necessarily to always find the "best" topic. For example, we decided not to include the concept of prerequisites directly into the Learning Guide database. Rather, a user is able to easily navigate to prerequisite topics by clicking on a hypertext link or selecting related topics. Additionally, through the use of priorities, we can suggest prerequisites before more advanced topics. Also note that the Learning Guide is based on the assumption that there are many (thousands) of content presentation pieces. They range from half a page of hypertext to fifteen minute quizzes to thirty minute simulations. The important issue here is finding the content out of a large content space. Anyone who has used the Web knows the inadequacies of methods like searching, hypertext and hierarchies. While each of these methods exist for the user in addition to the Learning Guide, the Learning Guide serves as an important starting point for users.

The Learning Guide's interface (see Figure 2) presents the user with CBT components that are likely to be useful. When the user launches the Learning Guide, they are shown all content related to a learning objective where a performance and training gap has been identified. This gap is measured through two *confidences*: performance confidence and CBT confidence. Performance confidence is a measure of how well the user has performed in on-the-job activities. CBT confidence is how much and how well the user has performed in related CBT components. In the next section, I will discuss this model in more detail.



Portfolio Theory	Test	70	3	
Overview		70	3	
Return vs Risk	Int Pres	70	3	
Bonds	KB Topic	70	3	
Stocks	KB Topic	70	3	
Mutual Funds	KB Topic	70	3	
Liquidity	KB Topic	70	3	
Short Term vs Long Term	KB Topic	70	3	
Investment Profiles	KB Topic	70	3	

Figure 2 - Learning Guide Interface

Confidences and the use of the Learning Guide are best illustrated through an example. Let's consider the situation of a particular customer relationship officer, Sue. On Saturday night, a batch process runs that looks at Sue's performance data (sales, contacts, plans, etc.). During this process, one of the rules flag that her sales of stocks is well below the expected levels for someone in her role. As a result, the process looks at the associated list of learning objectives and sets the performance confidence down. In this example, we'll assume that this performance rule has two associated learning objectives: one related to understanding stocks and the other to portfolio theory. Since Sue had previously taken CBT components associated with stocks, the total confidence (performance confidence + CBT confidence) for the stock learning objective is considerably higher than that for portfolio theory.

The next time that Sue logs onto the system, runs the Learning Guide, and requests recalculation, the system runs through the learning objectives finding any whose total confidence is below the threshold for her role as a customer relationship officer. In this case, the portfolio theory objective is identified as the lowest. The Learning Guide then displays the list of content items that relate to portfolio theory: a test on portfolio

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theory, an interactive presentation, and several knowledge base topics. Sue is able to select one of these topics and display it. If she selects a knowledge base topic, the result of that visit is that the CBT confidence goes up for portfolio theory (along with other related learning objectives) by some preset amount that we call a *factor*. If she takes the test and does well on the questions related to portfolio theory, again her CBT confidence will go up by some factor. If she looks at the Learning Guide again, the topics that she has gone to will still appear, but they will be marked as visited. If she requests recalculation, then the portfolio theory topics will have a higher total confidence and will have been removed from the Learning Guide list.

As stated previously, user control is central to the design of the Learning Guide interface. Some of the control is providing a longer list of finer grain CBT components and allowing the user to select from this list of "probably" relevant topics. The user is also given control through preference settings. The user can change confidence level thresholds across a variety of categories of learning objectives including system use, product knowledge, sales process and sales techniques. This allows the user to "turn off" general topics that they do not want to focus on. The user can also use the Learning Guide to select other job titles that they want to train for. The Learning Guide marks topics that the user has visited recently, and the user can set "not interesting flag" on topics that they want to erase from the list. This topic will not be shown again until some specified period has expired or the user asks to clear these flags. The user can sort the list by type, e.g., simulations, tests, knowledge base, etc. This allows the user to easily "test out" of some learning objectives. Other users can select content according to presentation style. Overall, these controls allow the user to determine the best use of the Learning Guide.

Learning Guide Model

The Learning Guide model is a database and associated rules that determine what information should be relevant to that user. This model is shown in Figure 3 which depicts the tables for the previous example. The tables shown in Figure 3 are obviously not the real tables, but rather are presented to give a flavor of the model.

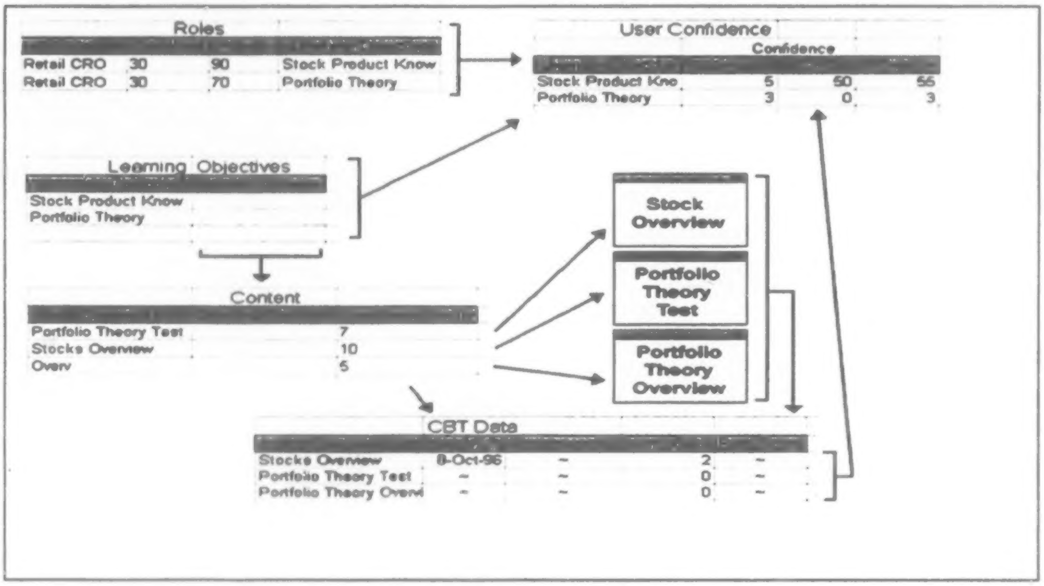
The starting points for the Learning Guide model are a list of learning objectives, information about content and information about roles as they relate to learning objectives. The learning objectives are detailed knowledge and performance requirements relating to sales process and sales techniques, products, planning, company information, and use of the system. Associated with each learning objective is a list of knowledge base topics, interactive presentations, tests, and simulations. The content of these related components help the user to achieve that learning objective. Also associated with each content item is a confidence factor that indicates how much CBT confidence should go up by completing that component.

Role information indicates default thresholds and priority for each learning objective relative to the user's job title (role). Users can select other job titles they are interested in, thus increasing the priority of some learning objectives. For this environment we found using job titles worked fine. In other corporate environments, users with the same title do very different work. In that case, job title would have to give way to more detailed job functions. However, the same basic approach of combining several job functions should work.

Each user in the system has a list of confidences associated with each learning objective. As stated previously, total confidence associated with a learning objective measures how confident the system is that the user has achieved that objective. As stated earlier, performance confidence is a measurement of system confidence based on job performance. Performance confidence is fully calculated once a week based on updates to performance data. CBT confidence is based on taking and doing well in related training components. Initially, CBT confidence is based on number of years experience at this company in this job and in other similar jobs, amount of system experience, and results of a preliminary on-line questionnaire. CBT confidence changes over time based on visiting knowledge base topics or interactive presentations related to the learning objective. They go up or down based on correct or incorrect answers in tests and simulations.

The more interesting aspect of this approach is the use of actual performance data in calculating performance confidences. The calculation of performance confidence looks at performance at several levels: strategic planning, making contact, contact effectiveness, and sales results. At the strategic level, individual users are provided with tools for planning customer contact over the next year and for the next week. Using a simple rule that compares the total number of planned contacts of various types against expected numbers allows us to flag performance gaps in strategic planning.

After strategic planning, the next step is to make the contacts that were planned. Using information about the number of planned contacts and the number of actual contacts, we can calculate confidence based on contact percentage. If the contact percentage falls below a threshold, we lower the performance confidence related to those learning objectives.


Roles
Retail CRO 30 90 Stock Product Know
Retail CRO 30 70 Portfolio Theory
User Confidence
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Learning Objectives
Stock Product Know
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Content
Portfolio Theory Test 7
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Figure 3 - Learning Guide Model

Assuming that the user is making sufficient contacts, the next check is to ensure the effectiveness of the contact. Because not all contacts are sales attempts and even not all sales attempts should result in immediate sales, it is important to closely categorize the type of contact. Many contacts are simply to increase customer knowledge, to handle customer care or to do other customer service free of any direct sales. Because we have categorized contacts into a variety of types, we can not only make sure that parts of the sales process like customer care are understood, we can also make sure that our system focuses the learning model on just the relevant sales opportunities. Specifically, the system looks for situations where a contact was planned with the intent to offer a product, the contact occurred, and the offer was not made or the offer was made and the product was turned down. On a case-by-case basis, these individual contacts can be explained away quite easily. However, a pattern often emerges that suggest some performance gap. For example, if contact is made, but the product is not offered (some other issue was discussed instead) and this happens repeatedly, then performance confidence gradually wanes in the objectives of turning contacts into sales opportunities. Thus, over time the system will begin to identify performance gaps, but at the same time the system does not necessarily focus on any one individual case.

Finally, we can use the benchmark of sales data. This data tells us how the advisor has done in selling specific products and product categories. We also have an expected sales level for each product category. Thus, when a user's sales in any particular product category falls below the expected level by some threshold, we lower the confidence of learning objectives related to that product. We also look at total sales; this can be a determinant of performance gaps in more general sales techniques such as needs analysis. Thus, even though the user may not fall below the threshold on any one product, the user may fall below the threshold on overall sales.

Conclusion, Related & Future Work

PS SMART™ is currently a prototype, and we are working on the development of the pilot version. While we will achieve more insight into the utility of the Learning Guide as it is used more across ever larger content, preliminary results are encouraging. Because the Learning Guide is limited in its goals and because there are other navigation (hypertext, search, and hierarchies), it appears to fill the important function of finding interesting starting content in large content spaces. It seems to avoid the problem often found in searching on the Web, namely where to start.

This approach and the goals of the Learning Guide are considerably less ambitious than Intelligent Tutoring Systems (ITS) which focus on emulating a human teacher's ability to plan a students activities based on domain knowledge, instructional models and student models. The Learning Guide does incorporate a student model in terms of content seen and performance both in instructional activities and on-the-job. However, the content presentation is more like that of standard computer-based training and hypermedia. Content presentation is not dynamically modified (as in ITS), rather it is only dynamically indicated what might be appropriate. In our environment, a high degree of user control was considered essential, leading the overall goal of guidance.

This approach is similar to the Guided Discovery System [Elsom-Cook 1990]. In this system, the user is guided to appropriate learning activities based on a network of learning objectives and their performance in learning activities. Many of the same approaches to deriving confidence were used in the Learning Guide, but the Learning Guide extends the confidence measures based on actual performance. Again, this is important in environments where a central concern of users is to "avoid content they already know." However, our initial findings suggest that further use of a model of content similar to Elsom-Cook's learning objective network may improve our guidance considerably.

While the basic structure of the Learning Guide has been designed and preliminary indications suggest it will be effective, we will gain significant insight into its usefulness during the pilot. During the pilot we will collect data to drive analysis of the effectiveness of the training. In fact, we should be able to measure all four learning evaluation levels as defined by Kirkpatrick [Kirkpatrick 1978]. During deployment, we plan to closely monitor situations where CBT confidence is high and performance confidence is low as this will suggest gaps in effectiveness of the training. We plan to also use data mining techniques to evaluate the correlation between system use and organizational outcomes including economic impact questions [Godkewitsch 1987]. Ultimately, we will try to tie together data at all four learning evaluation levels to improve training and further direct employee performance and learning strategies.

Overall, the Learning Guide model provides the basis for identifying topics that are likely to be relevant to users based on actual performance data. The Learning Guide interface provides quick, easy access to the topics and considerable user control in defining what is interesting to them. Coupled with development of architectures and engines [Karrer 1996], this serves as a cornerstone of the overall training and performance support approach within PS SMART™. Ultimately, it provides the basis of generating needed behavioral changes required to increase customer loyalty.

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A Virtual Laboratory for Beginning Scientists/Engineers

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Abstract: In this paper we report on the development of a set of "virtual" laboratory experiments, i.e., computer simulations, for beginning science/engineering students. Written in JAVA for use over the Internet, the simulations were designed to expose students to problems for which single, deterministic, "textbook" solutions do not exist. The experiments—ranging from the determination of the topology of hidden surfaces to the design of digital logic circuits—involve design, measurement, and estimation, and give students a taste of the range of problems found in engineering.

This virtual laboratory exists at **http://www.jhu.edu/~virtlab**

Overview

In this work we focus on two questions related to science/engineering education:

- An educational question: Could simulated experiments be developed to provide laboratory insight for students not having access to a physical laboratory?
- A practical question: Could interactive experiments be written in JAVA so that they might be delivered through the Internet?

The answer to both questions appears to be YES.

Here we report on the development of a JAVA-written, web-based "virtual laboratory" of interactive experiments designed to expose beginning science/engineering students to scientific inquiry and problem solving. These simulations will be organized into a freshman-level course, "What is Engineering?", to expose students to multi-parameter decision-making, approximation, parameter estimation, and data evaluation in a variety of engineering disciplines. Experiments include: inferring hidden surfaces, calculating heat transfer coefficients from holographic interferograms, programming robotic arms, and designing digital logic circuits.

At present, these modules are successfully replacing laboratory experiments in several existing university courses. Access is via the Internet.

This Virtual Laboratory can be reached at **www.jhu.edu/~virtlab**.

Introduction

Engineering (and science) curricula, at least up to the junior year in college, consist almost entirely of mathematics, physics, and chemistry. Although these subjects are certainly the analytical building blocks for the discipline, they do not teach students that engineering is an art that requires ingenuity, design, and creative problem-solving skills.

Throughout secondary school and continuing through the first few years of college, students study material by individual subject, one chapter at a time. They are then presented with problems for which there is typically one approach for solution, i.e., one equation found earlier in the chapter, and one explicit answer. In fact, beginning students are never given the opportunity to develop skills to deal with problems that are not simply "plug and chug". Only in junior or senior laboratory design courses do students begin to think about problems which require innovative approaches for solution. A recurring comment among professional engineers is that students need to learn to apply their analytical skills; and this can be accomplished by students taking more laboratory courses earlier in their academic careers.

There is a related issue. Students at four-year colleges and universities are typically offered a wide variety of science/engineering courses. Resources at these institutions include highly-specialized faculty and well-equipped science laboratories. But engineering students studying part time or students attending community-oriented two-year colleges will not necessarily have access to comparable courses, facilities, and expertise. For these students, opportunities to develop sophisticated engineering skills are often limited. Might there be a way to increase their exposure to laboratory-related problems without great expense?

The essence of engineering is learning how to think. It does not consist of carrying out calculations of well-posed, simplified problems. It is the process of translating real-world problems into ones which are amenable to solution. It is determining what types of solutions are needed. It is devising approaches that will yield adequate solutions. These are objectives to which students should be exposed at the beginning of their education, not at the end.

How does one teach students how to think? By exposing them to assignments that are open-ended--those that require hands-on exploration, those that are prone to measurement error, those that are too complex to be solved directly with simple analytical tools, those that require multi-parameter decision making. These are elements that are most naturally incorporated into task-solving laboratory courses.

A Virtual Solution

We are addressing these issues by developing a freshman-level, virtual-laboratory course, "Measurement, Experimentation, and Design". This course is being produced on a multimedia/WWW platform, so that its ideas and goals can reach beyond the campus of a research university. The heart of this course--what we are focusing on in this paper--is a Virtual Laboratory, a set of open-ended, thought-provoking experiments written in the programming language JAVA.

That a multimedia approach might be suitable for such a course requires some elaboration. First, whereas multimedia has always been capable of presenting audio, visual, and textual material, it has not provided the user with the ability to perform actions that alter the outcome or the data; i.e., one could never conduct a simulated experiment using conventional multimedia. With JAVA, however, it is now possible to create virtual experiments in which the user determines the course of execution. Second, since JAVA exists as a language within most Web browsers, users on all computer platforms have comparable access. Third, if one produces multimedia information trees using HTML and JAVA, then course material may be made available on individual CD-ROM or on Web servers without modification. What this means, is that course material may be offered locally or at a distance with equal ease.

Collective problem solving is also possible using this technology. If a virtual laboratory course were offered via the WWW, a central Web server could establish student groups, the members of which could interact via e-mail. Group assignments could be electronically assembled and sent to the central server for evaluation by a distant instructor. Existing software, e.g., Web Educational Support Tools (WEST), could be used for course administration over the WWW.

The Virtual Laboratory

We describe here five of the completed experiments in the Virtual Laboratory. Corresponding to each of these descriptions are Figures 1—5 which illustrate what is presented to students as they perform each experiment.

1) **Logic circuits**: Create circuits from AND, NOT, and NOR gates to effect logical outputs. Here, students assemble virtual components to produce desired logical properties. Circuits can be tested by assigning proper inputs and noting results. Assignments vary from simple three-input AND gates to multi-digit binary adders to robotic control circuitry.

2) **Drilling for oil**: Suppose it were necessary to determine the curvature and orientation of a stratum of oil-bearing shale. The depth at which this stratum lies can be only obtained by drilling a hole until it is reached, and then measuring the depth of the hole. Given a limited number of possible geometries, the problem is to determine the characteristics of this hidden surface at minimum cost. Cost factors include number of drill holes, terrain, and depth.

3) **Robotic arm control**: Consider a two segment robotic arm whose tip is required to move through a sequence of specified trajectories. Control is effected by prescribing the rates of change of the angles between the links; i.e., by prescribing the angular positions of stepper motors. Assignments include: Prescribe a set of commands that will cause the arm to traverse its range along the x-axis at a fixed elevation y to within a specified tolerance; deduce the range of action of the arm; prescribe a set of commands that will take the arm through its trajectory at constant speed.

4) **Heat transfer in a duct**: An experiment consisting of air blowing over a heated, ribbed surface is described. Motion holographic interferograms taken during the running of the "real" experiment are presented. The objective is to make measurements from these interferograms and deduce the Nusselt number--a measure of the heat transfer. The problem is to estimate temperature gradients based on visual data.

5) **Bridge designer**: This is a design platform for developing simple truss bridges. By creating nodes, connecting them with members, and adding loads, students can explore bridge designs and examine the compression or tensile stress experienced by every element of the structure. This module is used in conjunction with a project to design and build a load-bearing model bridge.

These modules are currently being used successfully as supplemental or replacement experiments in several existing engineering courses. Response has been very positive. Students find the problems interesting and challenging, and, since the "laboratory" resides on the WWW, students are not tied to performing the experiments in a designated time slot at a specified place. There are benefits for faculty and administration, too. Problems with scheduling, maintaining, and staffing laboratories are eliminated. Laboratory costs are drastically reduced.

Coupled with MPEG video lectures and supporting materials, these virtual experiments will be integrated into a complete multimedia, science/engineering laboratory course that can be delivered asynchronously anywhere.

Virtual laboratories are not a panacea. In spite of the fact that they can offer highly-interactive experiments, they cannot duplicate the experiences obtained in handling real apparatus. But, when laboratories focus on design or problem-solving and when lessons are not dependent on physical equipment, the educational differences between *real* and *simulated* narrow to the point where virtual experiments become very viable options.

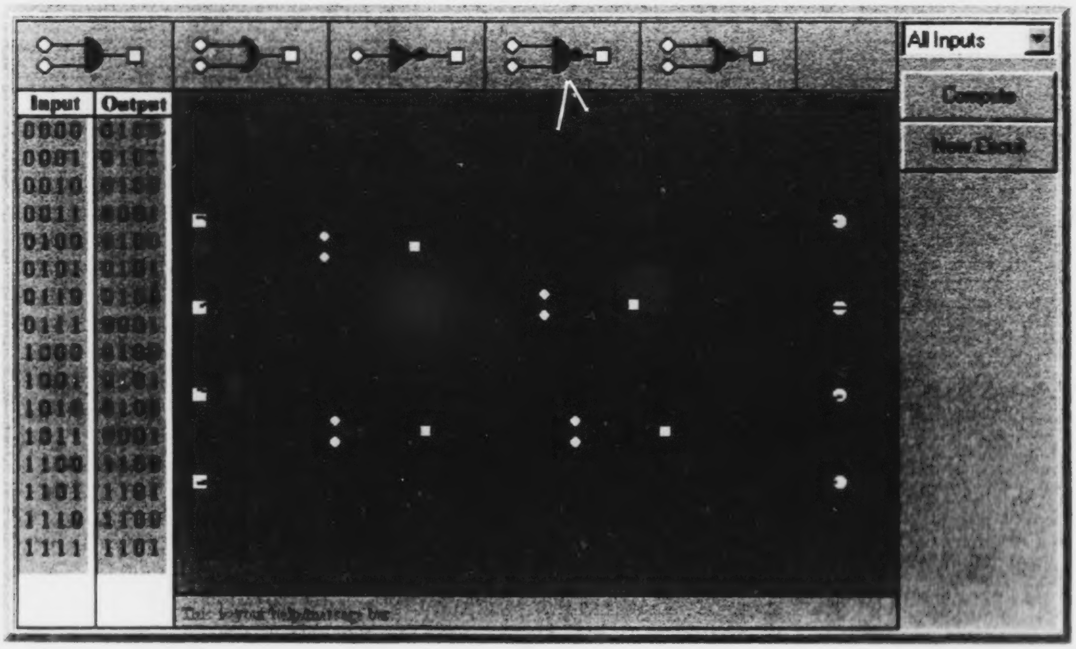
Real Problems

Creating virtual experiments is not for the faint-hearted. JAVA, WWW browsers, and client-server communication software are new technologies. Lack of documentation, un-implemented standards, browser inconsistencies, and constantly revised software make the development of simulated experiments a daunting task. We presume that, as these technologies mature, the majority of these problems will disappear and virtual laboratory and course development will become more practical.

Conclusion

Multimedia-delivered courses are not new. But multimedia-delivered courses that offer interactive laboratory work are. The present effort shows not only that such courses are possible, but also that they can be effective. And they appear to have the potential to extend the opportunity for science/engineering education well beyond the walls of the university campus.

Figures



Input	Output
0000	0100
0001	0101
0010	0100
0011	0001
0100	0100
0101	0101
0110	0100
0111	0001
1000	0100
1001	[illegible]
1010	0100
1011	0001
1100	1100
1101	1101
1110	1100
1111	1101

Figure 1. Virtual Laboratory: Logic circuits

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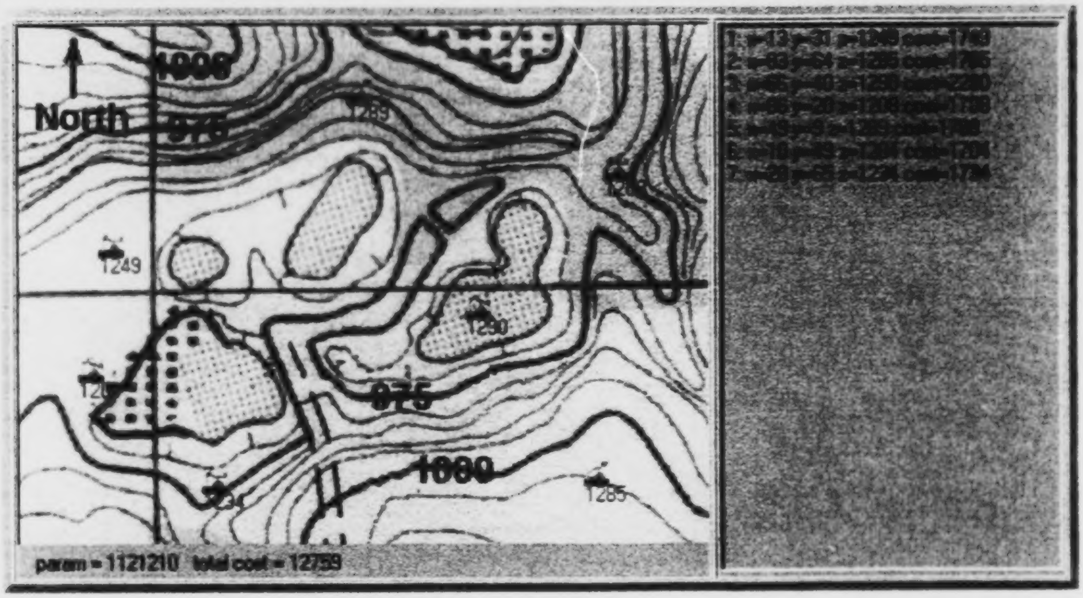
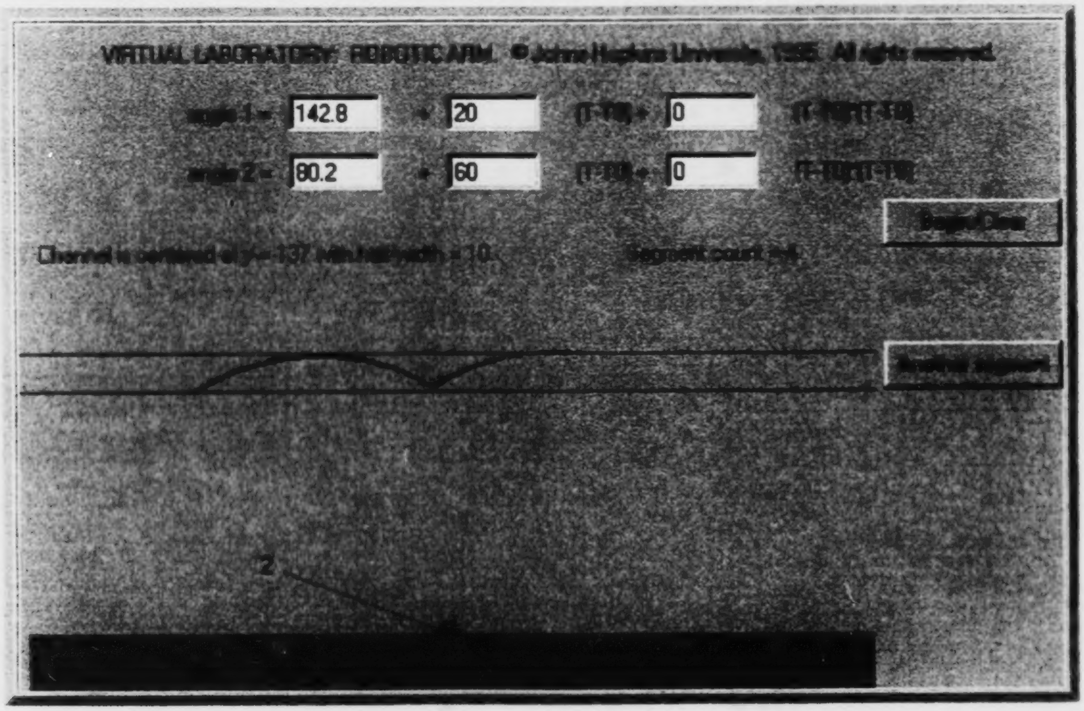

North
1000
975
1289
1249
1290
975
1000
1285

param = 1121210 total cost = 12759

Figure 2: Virtual Laboratory: Drilling for oil


VIRTUAL LABORATORY: ROBOTIC ARM. © Johns Hopkins University, 1995. All rights reserved.

angle 1 = 142.8 + 20 (T-T0) + 0 (T-T0)(T-T0)

angle 2 = 80.2 + 60 (T-T0) + 0 (T-T0)(T-T0)

Channel is centered at y = 137 min.half-width = 10.

Figure 3. Virtual Laboratory: Robotic arm control

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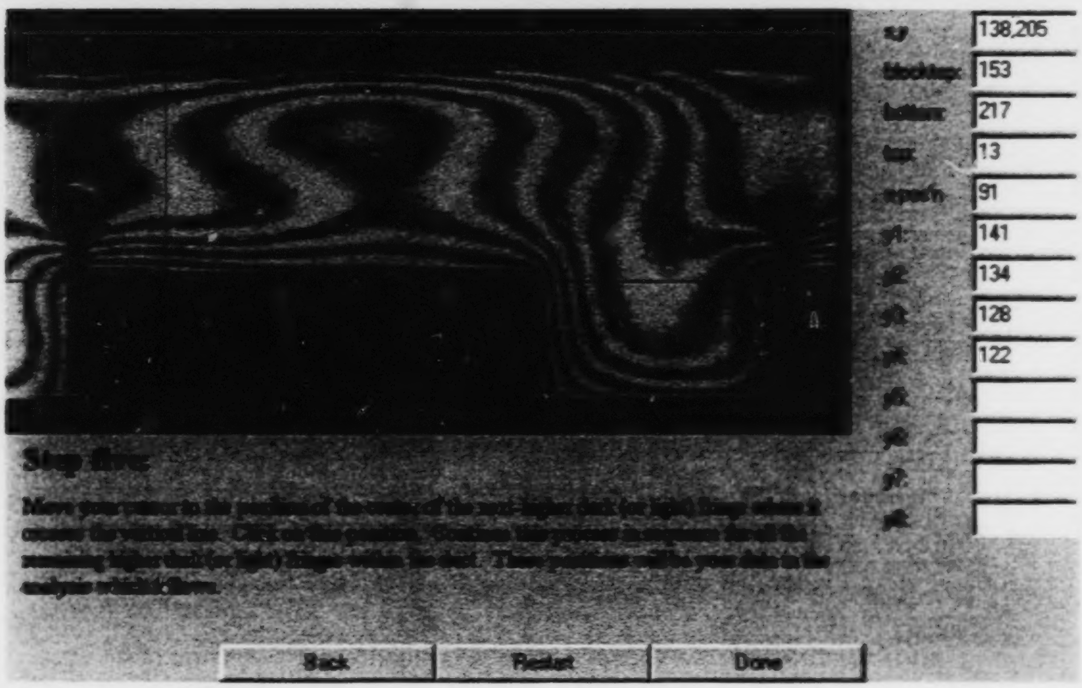
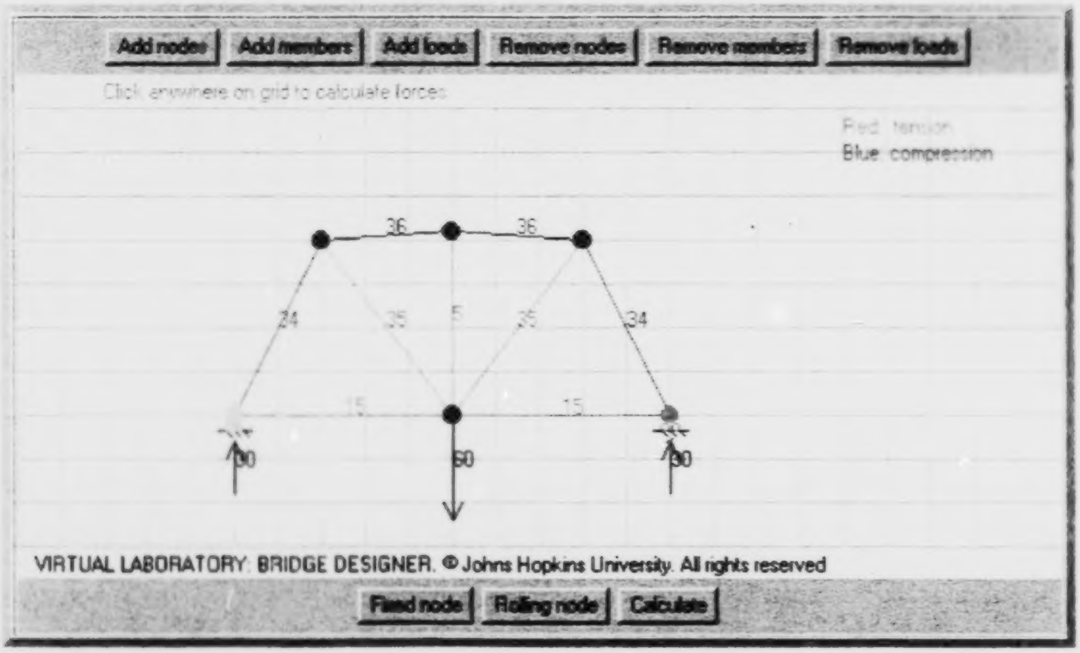


x,y: 138,205
blocktop: 153
bottom: 217
top: 13
npix/h: 91
y1: 141
y2: 134
y3: 128
y4: 122
y5:
y6:
y7:
y8:

Step five:

Back
Restart
Done

Figure 4. Virtual Laboratory: Heat transfer in a duct.



Click anywhere on grid to calculate forces

VIRTUAL LABORATORY: BRIDGE DESIGNER. © Johns Hopkins University. All rights reserved

Add nodes
Add members
Add loads
Remove nodes
Remove members
Remove loads
Red: tension
Blue: compression
36
36
34
35
5
35
34
15
15
30
60
30
Fixed node
Rolling node
Calculate

Figure 5. Virtual Laboratory: Bridge designer.

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Discrimination Learning: Coupling Categorization and Classification
Preliminary Research Report

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Introduction

A concept such as diabetes, or an object such as an F-18 fighter jet, can be represented as a category with a set of properties. In accordance with Rosch (1978), a category is a number of things considered equivalent, and has properties serving to distinguish it from other categories that are similar to it. Whether we deal with categories that are fundamentally perceptual and sensory like speech and color processing (Harnad 1987), or with abstract higher-order categories such as the PG ratings of movies, there exists both a *declarative* aspect and a *procedural* aspect to categorization.

Declarative is defined as all the prototype and boundary characteristics that define a category, and *procedural* is defined as the process of identifying an object (with one or more characteristics), as a member of that category, and not some other similar category. To learn a category one must deal with both aspects: learning the characteristics of a specific category, such as what is an F-18, so that from its identification a whole set of associated characteristics can be inferred; and also learning to identify the category that best fits a particular set of characteristics. These two aspects are referred to in this paper as *categorical* and *classification* learning.

Most approaches to the learning of categories are based on a didactic approach: linear and depth-oriented presentation of information, focusing on the detailed properties of the category in question. For example, we learn about diabetes by reading, or by being told information about diabetes as a disease. However, this model building does not necessarily create the ability to classify a set of symptoms (characteristics) as diabetes, because classification requires a breadth-oriented knowledge of how similar categories differ one from another.

In general, the characteristics of categories are taught and learned separately from the ability to classify things into their appropriate categories. This is not ideal, because the two kinds of knowledge are clearly inter-related. Knowing what is in a model (diabetes) is of limited value if one cannot diagnose diabetes; to diagnose diabetes, it is necessary to have an in-depth knowledge of diabetes.

The most common method for acquiring classification knowledge is through experience, rather than by establishing formal pragmatics for learning classification. In part, this is because of the difficulty of obtaining sufficient cases in an inquiry-based format with which one can practice classification; and, in part, due to the difficulty of providing appropriate feedback to the learner, in the form of inter-category distinctions.

Finally, if authentic tasks and situated context are critical to learning (Brown 89, Spiro 88), then providing an environment of appropriate context and near-real tasks in classification learning (other than in real training, or computer simulations) is essential. However, this has always been a challenge.

The summary of research on combat vehicle identification training for the period 1980-85 at Fort Hood, Texas (Smith 89) is indicative of the approach taken using manual techniques. Generally, slides and flash-card presentations were used. The results of training with five vehicles were good, but fell to an average of 30-35% when training was performed with 30 vehicles, which was accomplished with six modules over about 240 minutes in total time. Side-by-side comparison of similar vehicles, with features pointed out by instructors, gave remediation a 56% improvement. Attempts to find correlations of performance to student-intrinsic factors did not produce significant results.

Axia Multimedia Corporation has brought a highly interactive multimedia, student-centered approach (Chang 1993, 1994) to the learning of categories and their classification. Its Discrimination Learning engine provides authentic identification tasks, multiple representations of objects for comparison, uses questions to set contexts, and uses mis-identifications as opportunities for learning classification as well as categories.

This study, using the above approach, was undertaken as the first of a number of planned investigations into the nature of classification knowledge, and specifically, into the effectiveness and efficiency of learning both categorical knowledge and classification knowledge in a coupled way, so that one motivates, drives and informs the other.

Background

Axia Multimedia Corporation has developed a unique and patented approach to learning, called Discrimination Learning, which supports the incremental learning of classification skills and categorical knowledge (US Patent 5,449,293).

In terms of broad architecture, the Discrimination Learning Engine supports multi-dimensional comparison of a set of Items by using side-by-side windows, with a set of Aspect buttons between them. These Aspects are multiple representations of the Item set, while multiple Instances of an Item-Aspect, with secondary voice-over audio, labels and text (see Figure 1), provide levels of detail which are also a powerful scaffolding mechanism.

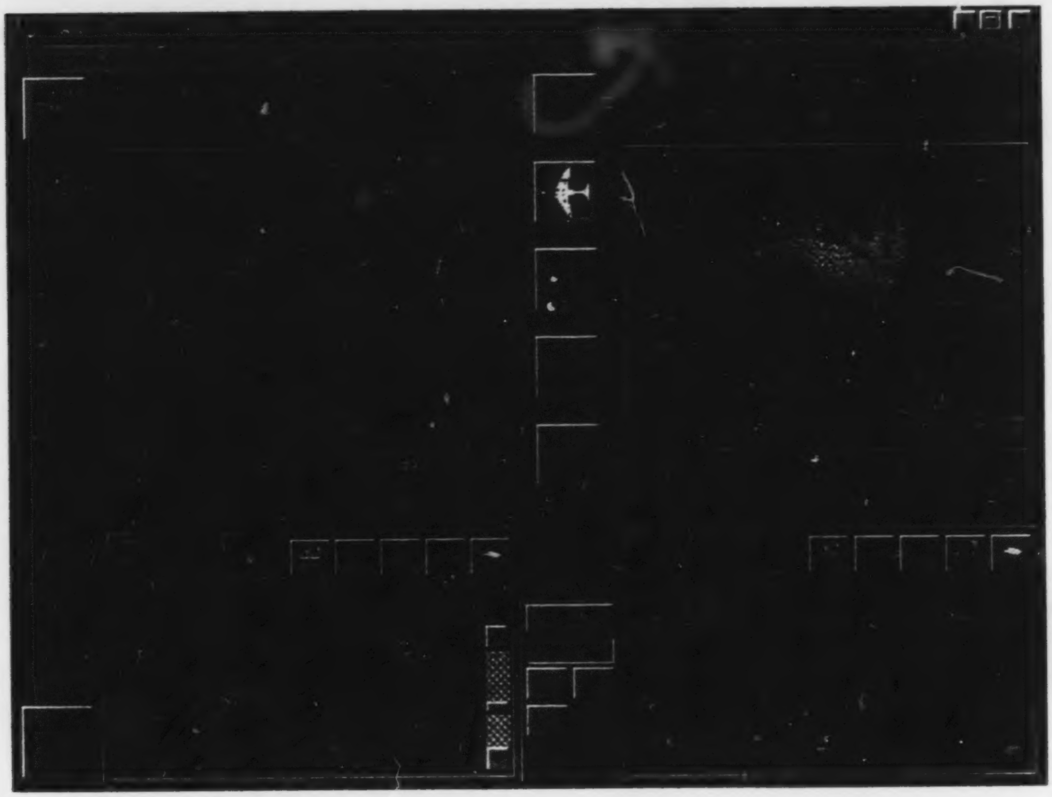

Figure 1. Discrimination Learning Engine - Know Your Combat Jets

Using Reference Mode, a student can select the same Item in the left and right windows, and compare different Aspects (representations), or different Items in each window, comparing them in the same representation, with or without labels or other detail.

Challenge Mode provides an inquiry-driven interaction in which the student is asked to identify the image, using the list of Items for answer selection, or typing in the answer. If a mis-identification is made, the system shows the user the Guess item, using the same representation as the Target (image to be identified). This allows the learner to compare them using labels, other Aspects, or attempt another identification.

To increase the authenticity of the task, the student can select a subset of Items, and can use the timer to limit the duration of the image on-screen. At any time, the student can click on the Answer button rather than making a Guess.

Incremental learning is a mechanism through which a student can choose the size-of-learning set with which to work, implementing a divide-and-conquer strategy. It is simpler to discriminate among three items than thirty.

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This research study was established with three broad goals in mind: first, the effectiveness of coupling categorical and classification learning compared to more standard approaches; second, the gaining of some insight into the response of students to open interface systems, which react only to the student's actions; and third, the gaining of insight into the extent to which students use different tool capabilities for learning.

Method

In this study, 56 military personnel were selected from various military units in Southern Alberta. The objective was for the soldiers to use the Axia multimedia product *Know Your Combat Jets* to study differences in learning effectiveness based on the theoretical framework presented earlier. Each soldier had up to 90 minutes to learn to identify 40 different fighter jets. The soldiers were provided with images of 40 selected jets which may realistically have been encountered while on a mission to Bosnia.

All the soldiers were first asked to fill out a personality inventory. They were then given standard instructions on the multimedia system's capabilities. The multimedia program had numerous components and the study was designed to assess different aspects of the Discrimination Learning engine. Soldiers were randomly assigned to one of three groups.

The first "*Reference Learning*" group, studied 40 fighter jets by their characteristics only (model building), with no opportunity to do classification until the test. The second, "*Challenge Q/A*" group, was allowed to use Challenge Mode, and was asked by the system to identify a fighter jet selected at random, but participants could only obtain the correct answer. This corresponded to classification only. The third, "*Comparative Feedback*" group, could use Challenge Mode, but had the added ability to submit a guess, which produced upon mis-identification a comparison feedback, showing the guessed aircraft in a side-by-side window next to the "target". This corresponded to the coupled categorical - classification learning group.

After the learning session, the soldiers were administered a test of their knowledge. The test bank consisted of a mixture of 40 photographic and silhouette images of the target jets, some drawn from the learning set and some from new sources. Each soldier's computer screen performance was videotaped for the duration of the learning session.

Results

The raw data consists of three sets of information: the answers provided by each soldier on the 40 item Jet Recognition Test, results of the personality inventory, and the video of the soldier's learning interactions, as seen from video tapes of the screens. Each question on the Jet Recognition Test required a typed answer, therefore, a scoring system was needed to deal with spelling mistakes and incomplete names.

To date, the 40 item Jet Recognition Test data has been analyzed and the tapes have been annotated in detail. However, neither the personality inventory nor the tapes have been analysed so only the test data and some preliminary observations from the tapes are discussed in this paper.

Jet Recognition Test Results

Table 1 shows the means and standard deviations of the three groups on performance in the Jet Recognition Test. As can be seen from the data, the "*Comparative Feedback*" group performed the best, although the overall average of 8.34 is quite low relative to a perfect score of 40.

Group	Count	Mean	Standard Deviation
Reference Learning	19	8.42	4.10
Challenge Q/A	18	6.28	4.56
Comparative Feedback	19	10.21	4.64
Total	56	8.34	4.64

Table 1

Means and Standard Deviations of the Model, Classification and Classification Category groups on performance in the Jet Recognition Test.

As can be seen in Table 2, a standard one way analysis of variance on the Jet Recognition Test shows that there is a significant difference in performance between the three groups (df = 2,53; F = 3.64; p < .05).

Source	D.F.	Sum of Squares	Mean Squares	F-Ratio	F-probability
Between Groups	2	143.15	71.58	3.64	.033
Within Groups	53	1043.40	19.69		
		1186.55			

Table 2

Analysis of Variance for Model, Classification and Classification/Category groups on performance in Jet Recognition Test

A subsequent *post hoc* Scheffe test showed that the "*Comparative Feedback*" group performed significantly better than the other groups. While this represents the traditional method of analyzing the data, a more visual representation of the data can be seen in Figure 2.

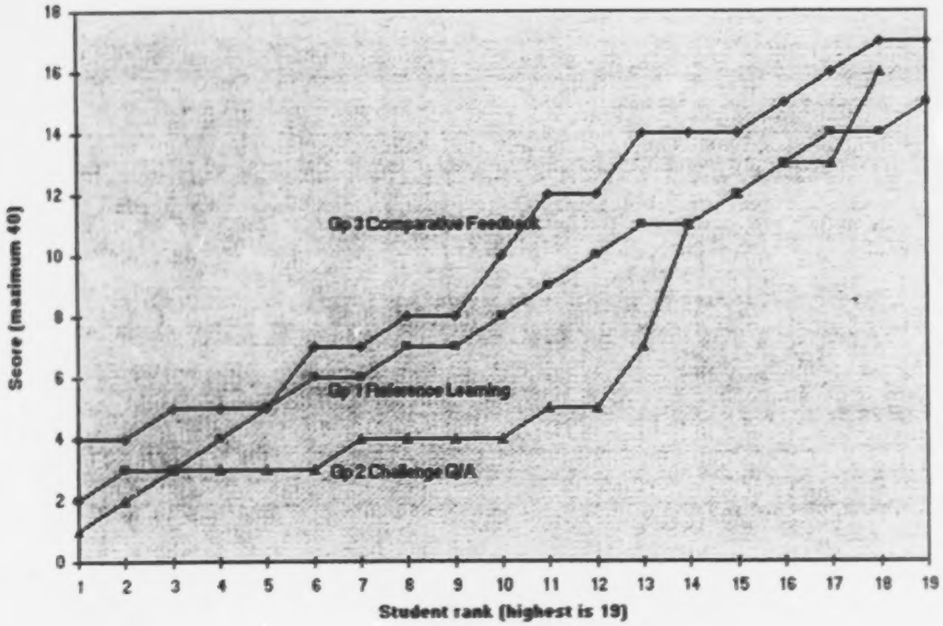

Figure 2. Comparison of Three Learning Strategies Using KYCJ

As can be seen in Figure 2, soldiers are listed by group from lowest to highest performer. If one assumes random assignment, then ability should range in each group from low to high performers irrespective of treatment. If there is a significant difference between groups, then there should be a consistent, parallel separation between the slopes of the groups. This new method of representing the data gives the researcher a much clearer understanding of the data and is highly recommended.

Preliminary Videotape analysis

From the videotapes, it appeared that most soldiers finished the learning session before the 90 minute time limit. Only a few soldiers used the levels-of-detail features of the program such as the labelling component which allows a learner to distinguish among characteristics of an aircraft. None of the learners used a divide-and-conquer strategy of incremental learning, nor did anyone use the Timer, to improve expertise. Most soldiers did not use multiple representations; that is, study an aircraft in photos and technical drawings and silhouettes, nor did the "*Comparative Feedback*" group follow-up a mis-identification by exploring the similarity space around the Target image.

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Discussion

Jet Recognition Test Results

As can be seen from the results, Jet Recognition Test results were quite low, averaging 8.34 out of 40, or 21%, with a high score of 26%. These results were obtained from one learning session, with a maximum of 90 minutes in which to learn 40 combat jets. These results are consistent with the Combat Vehicles Identification studies (Smith 85), which ranged from 30% to 35% where the task was to learn 30 vehicles over six session involving 240 minutes. Despite the overall low scores, there were definite group differences.

The "*Comparative Feedback*" group scored significantly higher than the other two groups, with an average of 10.21 of 40, compared to 6.28 out of 40 for the "*Challenge Q/A*" group, which represents a difference of 63%. The visual analysis of the data as seen in Figure 2 shows remarkable consistency over the entire range of ability levels, as illustrated by the essentially parallel lines for "*Comparative Feedback*" relative to the other groups.

Although the *post hoc* Sheffe test did not show a statistical significance difference between the "*Reference Learning*" group and the "*Challenge Q/A*" group, the visual analysis and the data suggest that the "*Reference Learning*" group may have performed better than the "*Challenge Q/A*" group and the researchers are currently undertaking another study to clarify this issue.

From the results, it would appear that Comparative Feedback is a much more powerful learning method than either Reference Learning or using test and right answer feedback. If these differences are real, then there are major implications for the standard test and right answer feedback models currently used in most educational situations.

A possible explanation for this outcome is that students when answering an identification question may postulate that the observed features belong to a category representing the answer, and make cognitive commitments in that respect (i.e. the category chosen as the answer is the focus of attention). Upon being told that the answer is wrong, and shown the right answer, significant work must take place in order to shift the focus of attention to the right answer, and to fit the appropriate features to the new category.

The "*Comparative Feedback*" group, by contrast, is shown an image corresponding to the mistaken answer, with all its features, so that learners can first revise the internal map of the features from the incorrectly chosen category which was the focus of attention. Then, the learners can construct the between-category knowledge of differences, thereby improving knowledge on both objects.

Preliminary Video Analysis

While the soldiers were allowed 90 minutes to complete the project, only a few actually used the full amount of time. In view of the overall low scores, there appears to be a remarkable discrepancy between the results and the learners decision to test without taking advantage of the full training time.

In addition, it was clear that few of the students used the scaffolding mechanisms present in the Discrimination Learning Engine, all of which were demonstrated at the beginning of the training session. These mechanisms include labels, text, multiple representations, comparison, incremental learning, and the image presentation timer.

Assuming that motivation was present to learn, and that the interactive learning environment was itself motivating, it would appear that soldiers in the research study did not appreciate or understand the value of the interactive learning tools and therefore they did not use those tools to improve performance. For example, displaying the labels tool would have unequivocally shown that the EA6-B Prowler is different from an A-6 because of the radar bulge on the top of the tail. Since none of the soldiers utilized this tool, they confused the two aircraft on the test. If they knew from the introduction that labels gave information about the distinctive features of an aircraft one wonders why they did not use the tool. Moreover, soldiers did not accurately evaluate their level of acquired knowledge relative to the test requirements, effectively declaring themselves ready to test when they were actually unprepared.

In summary, there are three findings from this preliminary study which need further analysis and replication.

1. Coupling categorical and classification learning is more effective than memorization, or being given the right answer in quiz mode,

2. Just giving the right answer to a wrong response in a discrimination learning task may actually impede learning, and

3. Learners do not use tools which could enhance learning and do not take full advantage of learning time possibly because they overestimate their knowledge.

Given the relatively poor results, even for the "*Comparative Feedback*" group and the non-optimal use of available tools, the researchers are conducting a follow-up study with Military Cadets. In the follow-up study, more explicit instructions and strategies on the use of scaffolding tools will be incorporated into the design.

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Multimedia: Promises to Keep and Miles to Go...

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Abstract
The vision of multimedia, technological innovation, learning and entertainment, evokes an intriguing and exhilarating blend of possibilities in an educational realm with promises unfulfilled. Such a relationship has great potential. As technology moves toward integrating telephone, television and desktop computing, and as our students develop more sophistication with the use of technology, we have to start questioning our role as educators. This paper attempts to "eschew obfuscation" and examine the evolution of multimedia as a valuable learning and information resource--its potential, and its peril.

In The Beginning...

Over the last twenty years, technology has evolved faster than anyone could have predicted. Every year since 1978, I have shown my students a picture of two children walking toward their school only to be greeted by a 'Robot' teacher. One child says to the other "I have a feeling things are going to be different this year". Amusing, yet, the vast majority of teachers, schools and universities throughout the world are using the same methods of teaching that have been employed for over one hundred years. An argument could be made that slides and other audiovisual aids make a difference, but these "technological innovations" are essentially just being integrated into the old way of doing things.

The world wide web is being used, even by the more adventuresome of our colleagues, simply as another method of presenting lecture notes. This Piagetian paradigm of "assimilation" involves taking new things and attempting to fit them into existing models. Posting lecture notes on the world wide web for students to read is not so very different from photocopying lecture notes for distribution in class. Although posting on the web may save paper (unless the notes are printed off) and is effective for updating information, it is a major disadvantage for the socioeconomically challenged students, and ties the student to a computer monitor.

The very first computer-assisted instruction programs consisted of converting math lectures for presentation on a computer screen, with electronic page turning. At the end of the computerized lesson a drill and practice session would be introduced using the same type of questions usually located at the end of a chapter in the standard mathematics textbook. A major advantage of the computer was the immediate feedback to the learner. The computer could quite easily tell you to "try again", with infinite patience, perceived dedication, and an occasional "please concentrate' or "well done".

Again, this is an example of using technology to do things the same way as before only perhaps a little faster, better, easier, and in a more accessible manner. This is far from using the full the potential of technology--that would require completely different models for teaching and learning.

In the early years of computer systems the speed was such that you could go out for a coffee while a program was loading. It is interesting that in using the world wide web, we find ourselves waiting again. Have we really progressed? Now we use the computer to present graphics and audio/visual information and call it multimedia, but the video quality on our computer screens is substandard to that of television which has been available for over 40 years.

Multimedia, not...

Is it not intriguing that our children think the painter of the Cistine Chapel is a Ninja Turtle, or that the most widely recognized personality amongst North American children is the plumber, Mario--a flat, undeveloped animation character. At least our generation in its youth identified with a wacky mouse that was fully endowed with a 'wired', multi-faceted personality--the immortal Mickey. Neil Postman in his book, "Amusing Ourselves to Death" points out that mankind has an insatiable appetite for distractions. Certainly, technological toys and gadgets will feed that appetite, but we run the risk of becoming a trivial and shallow society.

Multimedia is not just the integration of the various media (audio, video, graphics, slides, animation, text and technology), but also the interaction of technology and people. The most inexpensive and sophisticated human computer interfaces available today are aimed at the video games market and are being purchased for children. High technology, interfaces, virtual reality head-sets and power-pads are built at the cost of millions of dollars and mass marketed by companies such as Nintendo^{TM}, who have "captured your dollars and enslaved your children" (Sheff, 1993).

Multimedia is still in its infancy and already there are thousands of titles, most of which do not return profits to their developers, Miller (1994). Many multimedia titles remain unopened after purchase. Analysis of the most popular and widely distributed titles shows computer games as the leading category (Sheff, 1993)-- and not just for children.

Many technology users spend huge amounts of time surfing the "web" and yet we still do not have a clear picture of why this is so. The world wide web has amazing potential and is growing faster than any other single product in the history of mankind. It is a place where, at long last, every man, woman and child has the opportunity to realise their promised "15 minutes of fame". By posting your own web site, you can have recognition world wide, no matter how obscure your ideas may be. Add colour, video and sound, call it multimedia and who knows what you can achieve?

The Issues...

Ashleigh Brilliant suggests that there has been an alarming increase in the number of things of about which we know nothing. Perhaps, multimedia and the world wide web provide people with easy access to answers to questions that arise at the most inopportune times. But, how do we know that the answers they find are correct? How does one collect, analyze, verify and integrate new knowledge into existing systems? How do educators help their students to create and disseminate new ideas and knowledge? How does one reexamine the way we do things in the light of new technologies. It should come as no surprise that computers can play chess better than the best human chess player and win the game and yet humans continue to play chess with one another. With multimedia, will computers teach better than the best human teacher and replace them? Is that the right question to be asking? Humans create the technology and challenge it, but still require human interaction to excite the emotions and enhance the quality of life.

The traditional system of education deals with learning from a linear perspective (lectures, textbooks, assignments, tests and due dates). Howard Gardner (1983) addressed the issue of multiple intelligences and suggests that there are at least seven different intelligences, most of which have been neglected in our test oriented society. Multimedia, in the broadest sense of the word, can address a multitude of learning styles and rework the system so that students can use existing knowledge to create new knowledge, and move from passive recipients of information to active developers. Essentially, students can become active participants in planning and creating their own learning opportunities.

Despite the fact that technology provides us with amazing opportunities and potential, in the field of education few people are integrating technology effectively into their teaching and learning. Perhaps it is a combination of ignorance, fear, lack of time, or a resistance to change, but it is clear that the next generation of students will arrive at universities with experience and expectations which will drive change or which will result in the obliteration of the institutions as we know them today.

One of my students tells the story of her eight year old son who woke up at two in the morning and discovered his mother in the study working on a multimedia project. He sat watching her in deep fascination for a prolonged period and then said to her: "How come you get to do all this interesting stuff and I have to go to school?"

It was stated earlier that most educational facilities have yet to incorporate computer technology into their existing systems. Perhaps it should be asked if technology should be changed to fit existing systems, or is it time to change existing systems to fit into the new communication era?

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Rethinking the Implementation of Distance Education Programs

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Abstract: In early September, 1995, three institutions in Alberta, Canada, embarked on a new partnership in offering a selected number of introductory Bachelor of Arts courses in remote northwestern regions of the province. The primary mode of delivery was multi-point videoconferencing with all courses delivered from the University of Alberta campus. Slightly more than 70% of the student cohort for the first academic year were Aboriginal. This discussion highlights the implementation and formative evaluation of this partnership, and proposes recommendations for the effective planning and implementation of distance education initiatives.

Introduction

The need for greater understanding of administrative issues in distance education has been echoed by a number of authors. Murgatroyd and Woudstra [1989] observe that " Of all the areas of study in the field of distance education, the field of management appears most neglected" [p. 15]. Moore [1994] reinforces the need for examination of administrative issues. He suggests that " "the barriers impeding the development of distance education are not technological, nor even pedagogical . . . . The major problems are associated with organizational change, change in faculty roles, and change in administrative structures" [p.4].

These calls for more understanding of the administration of distance education have not, it seems to me, produced systematic attempts to link the basic questions in distance education to possible solutions which could be offered from fields such as business management and educational administration. This may be partly because the establishment of such a link will require adjustments in thinking in both fields. The discussions which do exist tend to deal with larger issues such as strategic planning or policy change. There is thus an emphasis on the "big picture" questions of institutional governance without an accompanying focus on how one successfully accomplishes the implementation of what policy makers decide "ought" to be done. Fullan's [1991] comments on this conspicuous gap are instructive here. He states, "Commitment to *what should be changed* often varies inversely with knowledge about *how to work through a process of change*"[author's italics] [p. 95]. In the case of program implementation, this statement appropriately expresses the distinction between the identified need for change, and actual program improvement.

In early September, 1995, three institutions in Alberta, Canada--the University of Alberta, Fairview college, and Kayas Cultural College--embarked upon the University Studies Project, a new partnership offering a selected number of introductory Bachelor of Arts courses in remote northwestern regions of the province . The primary mode of delivery was synchronized, multi-point videoconferencing (to as many as six sites) with all courses being delivered from the University of Alberta campus. Instructional support included the use of the Internet and a University of Alberta WWW page in conjunction with the videoconferencing medium. Slightly more than 70% of the student cohort for the first academic year were Aboriginal. This discussion will describe the implementation and report findings from a detailed evaluation of this partnership. The focus is primarily administrative in that recommendations will be provided for the effective planning and implementation of distance education initiatives.

The Project

Collaboration occurred between three quite distinct institutional entities: a comprehensive undergraduate and graduate level research university, a trades oriented rural community college, and a non-accredited community based organization, the primary function of which is to informally provide educational and other services to a geographically dispersed Aboriginal population. The theoretical framework for implementation encompassed problems and solutions at a number of levels including institutional cultures, planning and administration, instructional adaptations and course content, technological factors, student support systems, promotion, program costs, and legal/intellectual property issues.

Four 1st-year Faculty of Arts courses were selected for videoconferenced delivery from the University of Alberta campus. Implementation of the program began in late June 1995, and was essentially complete by the start of the 1995-1996 academic year, with most major operational elements in place. In September, 1995, the student cohort consisted of 39 students at three sites within the Fairview College system and at three sites within the Kayas College region.

The Evaluation

A research design with emphasis on multiple forms of data collection was deemed most appropriate for the evaluation. An advisory committee was set early in the process to define the parameters of the study and the evaluation questions, and to review the survey instrument and data collection procedures. Rather than a single researcher, a research team was used, both for data collection and particularly for data analysis and interpretation of findings. The research team consisted of the principal researcher (myself) and three research assistants.

Four methods of data collection were employed: (a) written surveys to students, (b) both individual and focus group interviews with counsellors, tutors, administrators, and instructors as were deemed necessary, © classroom observation of teaching and learning processes, and (d) document analysis. Interpretation of data and definition of findings was based on consensus among researchers, and therefore subject to what was, in essence, a continual peer review process. Additional verification of findings was obtained through feedback from members of the advisory committee, and where possible (in the case of interviews and observations), members of respondent groups, including students, counsellors, and instructors. This, and the use of a research team, enhanced the overall credibility of findings and reduced the possibility of bias by a single researcher in interpreting results. Findings from multiple data sources were used as a triangulation method to strengthen the validity of interpretation, results, and recommendations.

Findings are generally consistent with other recent research on similar programs [see Sorensen 1995]. In all, from a cohort of 34 students in December 1995, 29 usable questionnaires were returned. Out of all respondents, 26 students (90%) were 25 years of age or older at the time of the study, and 27 students (93%) were female. Nineteen respondents (65%) had one or more children under the age of 6 years, and 20 (69%) had one or more dependent children 6 years of age or older. A total of 14 students (48%) indicated some level of college training or completion of a college or technical school diploma as the highest level of education attained prior to admittance to the project. Another 10 respondents (approximately 34%) indicated completion of a general education diploma or high school diploma without matriculation. Although attempts had been made at a promotional campaign during the brief time prior to the start of classes, 15 students (slightly over 50% of the respondent group) had first become aware of the program through word-of-mouth. The main reason for students taking courses in the project was that they planned to seek university transfer and on-campus degree completion later. Of those responding, 22 students (76%) indicated this.

Based on student surveys, and through analysis of other data sets, planning and administrative issues stood out as one major area of concern. Students expressed a desire for more course and program information during the admissions and registration process, more effective program advising and counselling support, and improvement in turnaround time for screening and acceptance into courses. Thirteen students (52% of those responding) indicated a preference in the scheduling of courses for one-hour classes 3 times per week, and another 8 (32%) for one-and-a-half hour classes twice a week. The three hour block seemed to be the least preferred choice. When questioned on start-times for classes, 17 students (65%) indicated the 8:00 am to 4:00 pm weekdays time-slot as a preferred choice.

Data were also obtained on satisfaction with various aspects of the delivery medium and how these related to interaction, and on physical environment conditions associated with the medium and facilities provided. On average, students seemed satisfied with such factors as ability to concentrate, interaction with other students, class attendance, and disruptions. However, review of written comments by students showed concern over the extent of student-instructor communication, and also over student access to instructors through additional teleconferencing "office hours." Overall, students complained of the need for more convenient scheduling of office hours, and more immediate access to instructors.

A number of question items were designed to elicit data on the extent of contact, the ease of contact, and the value of consultation with counsellors, tutorial staff, and instructors outside of class time. It was found that significant percentages of students had much less contact with counsellors, instructors, and particularly tutors, than was originally assumed. The majority of those students responding appeared neutral on the helpfulness of consultation with counsellors, while 7 students (32% of those responding) perceived consultation with tutors as not at all helpful.

Overall, the most frequently mentioned weakness of the project was poor turnaround times for transfer of documents, assignments, and instructor feedback and assessments. Counsellors, instructors, and particularly students also reported a need for more university library support. Students called for access to more books and other materials,

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and the possibility of small reference collections made available at various sites.

Despite these inadequacies, this program is considered a moderate success, given the approximate 51% completion rate and an overall mean grade point average in four courses for those completing of 5.2 (on a 9-point scale). In all, inadequacies in the first run of this project point quite clearly to the need for enhancements in the various forms of student support. Responses on administrative issues point to a need for more intelligent and adaptive policies and procedures for distance education programs.

Recommendations

Management perspectives in distance education will themselves need to become more educationally accountable. In part, this means that such perspectives must address the need for concrete and positive results in terms of completion rates, student learning, and overall student success. A focus on the effectiveness of implementation will provide greater understanding of the type of change which may be required, and at the same time constitutes an attempt to re-align administrative discussions toward providing clearer guidelines for implementation planning and action.

In attempting to contribute to such discussions, I propose that great advantage can be obtained by viewing the implementation of distance education programs as the *management of innovation*. The recommendations which follow stem from this basic premise. In essence, it is suggested here that such a view best enlightens what is actually taking place, especially in those initiatives where the institutions and stakeholders involved are relative newcomers, both to technology and distance education.

The suggestion that the implementation of distance education be viewed as the management of innovation will not be a new idea for those familiar with distance education literature or technological innovation. It is accurate to suggest, however, that the clear articulation of those characteristics of innovation which are most relevant to the implementation of distance education programs has not been forthcoming.

The following recommendations are best taken as guidelines for thought rather than as recipes for success. I suggest that these recommendations are not only relevant to the specific type of program discussed here, but perhaps applicable across a wider variety of distance education initiatives. They are as follows.

1. ***Comprehensive planning***. Given the obscure nature of innovation, any model, system, or plan for implementation will necessarily be comprehensive, in that it must account for multiple factors and variables influencing success, and therefore complex, in that the interplay among influencing factors and variables and program success will be far from simplistic or superficial in nature. Research knowledge, information, and evaluation findings relevant to the type of program being implemented will be a key element in the process of planning.

2. ***Collective change***. In order for the innovation to take hold and result in sustained educational improvement change must occur on an operational level; behavior patterns and the functioning of the organization must change in cooperation with change in the behavior patterns of individuals.

3. An interventionist approach. An interventionist strategy for implementation means that: (a) change is not initiated from within, by the group to be changed, but rather from without, by an external agent; and that therefore (b) a single and clearly defined innovation with a specific objective is planned and in turn linked to the strategic view of the change agent. In the case of the present initiative, change came primarily from the university side, however, it should be noted that the inter-institutional nature of the University Studies Project presents a special range of obstacles. In order to achieve success, change must occur in the habits of both institutions, partly based on how institutional responsibilities are defined. [See Jones & Lewis 1991, for a more detailed explanation of concepts related to recommendations 2 and 3 above.]

4. Flexibility, feedback, and organizational learning. Nothing is defined for certain. Innovation, by definition, will tend to be ambiguously defined and allowances must be made for feedback, assessment, and redefinition of any aspect of planning. The result of the innovation will be organizational learning, and in turn, this will require strategies and models with flexibility and feedback loops.

5. Collaboration. The nature of many important aspects of the initiative must be essentially collaborative in nature. There are two main reasons for this. First, collaboration goes hand-in-hand with enlisting the support from key stakeholders and decision makers which is so necessary to success. Second, collaboration allows members to assimilate and understand--to learn--what the initiative is really about. This, in turn, is an important step in changing the behavior of the organization itself, which in turn is the end goal of the change initiative.

*6. **Evaluation***. This component needs to be taken seriously as an important step in providing a knowledge base for policy decisions and program development. In part, this means that research questions and evaluation designs must be tailored to the nature of the project evaluated, and findings must be examined in the light of realistic expectations. Evaluation needs to be removed from the "back end" of program planning and be seen as an essential part of implementation itself.

*7. **Student support systems***. Extensive research findings indicate that no direct link has been established between delivery mediums, levels of interaction, and their effect on student achievement [see numerous studies including Fulford and Zhang 1993; Kendall & Oaks 1992; Ritchie & Newby 1989; Russell 1992, 1993, 1994; Stubbs & Burnham 1990; and Tobin 1995]. If these variables do not influence achievement, then what does? One possible answer seems to point in the direction of various forms of student support services. This was confirmed in the evaluation of the University Studies Project and has been suggested by others. Tobin [1995], after review of literature on the subject, explains, "Research with students, . . . indicates that their success is closely tied to the provision of these services" [p. 207]. Brindley and Jean-Louis [1990] reinforce a similar view with this comment : "We believe very strongly now that we must move in the direction of an interventionist model of support services" [p. 69].

Planning and implementing systems of distance education focused on the efficiency of technological functioning accounts for only one dimension of a multi-dimensional process. To take a more service-oriented approach is simply to recognize that along with technical operations comes a variety of administrative, instructional, tutorial, and other forms of support which appear to be critical to student success, and therefore intimately linked with educational accountability. A comment by Bates [1995] encapsulates the educational common sense of such an approach: "Technology is not the issue. The issue is: how and what do [we] want students to learn? . . . concentrate on designing the learning experience and not on testing the technology" [p. 14]. It is suggested that the recommendations presented above move toward this larger view of distance education programs.

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Using Multimedia for Teaching Students with Special Needs

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Abstract
Education for students with special needs demands a large amount of funds, time and resource materials. This paper will address this problem by integrating special education strategies into a multimedia system within a regular education environment. Typical teaching methods and cognitive strategies for special education will be described. Issues arising from their implementation in actual education will be discussed. Based on the identifiable benefits of multimedia applications, the utility of multimedia concepts to address these issues will be discussed. A multimedia-aided teaching model for special education will be suggested.

1. Introduction

In the past, students classified as needing special education were educated in segregated special schools where a range of teaching methods and strategies were successfully developed and implemented. These specific teaching methods usually require customised instructional materials, additional equipment, specialised training, and a high teacher-to-student ratio. Currently, special education can take place in the whole spectrum of educational settings. In a regular school, it can occur within a special class, an educational support centre or a regular class. Special needs may exist across the academic, physical, behavioural or communicative dimensions [4]. Instruction within special education is individually planned, systematically implemented and carefully evaluated to assist exceptional learners to achieve successful outcomes and optimal independence. The current trend is to integrate most students with special needs into regular education. However, funds, time, resource materials, specially-trained teachers and support staff are scarce in this educational sector.

Multimedia in education has demonstrated benefits for improving educational quality. Assistive educational products using multimedia have extended the range of instruction available to suit the needs of students in special education. These use the multisensory capabilities of multimedia to offer presentations according to special needs. Multimedia can support more than one teaching method as well as enhance learning by more than one way of presentation. In addition, it can provide a flexible learning system which can address problems of funds, time and participation [15]. Flexible system delivery associated with educational computing technologies may improve the learning process in cost effective ways. This method can also increase access to educational opportunities for students and it can facilitate flexible participation for teachers and students.

This paper investigates the current teaching and learning strategies used in special education. The useability of multimedia in special education will be broadly examined. A model will be constructed based on the current infrastructure and philosophy in special education and the perceived benefits of multimedia to meet the needs of the students. Special considerations are suggested for the presentation of multimedia documents in the model. Issues which may arise from the applications of the model will be discussed.

2. Teaching Students with Special Needs

Special and regular education share a common goal which is to produce a student who can transfer learned skills to other settings. This enables the student to become an independent member of the wider community. Special education has its own set of pedagogical principles and practices. Some of their teaching methods have also been valuable for regular students. The most obvious differences, when teaching students with disabilities, are in timing and pacing needs. These needs are a consequence of psycho-motor, cognitive or sensory deficits.

Teaching methods in special education have derived from six main theoretical models: medical, developmental, ecological, humanistic, cognitive and behaviourist. This section focuses on the most popular methods emanating from the cognitive and behaviourist theoretical models.

The cognitive model has had a strong influence on special education methods, particularly cognitive and metacognitive training methods [6]. The cognitive theories explain such processes as attention, perception, memory, conceptualisation, comprehension, reasoning, problem-solving and decision-making. Different cognitive theories provide different explanations of the underlying cognitive processes. The information processing theory (IPT) is the most popular cognitive theory applied in the area of computing and is used as a frame in artificial intelligence design [8]. It provides an understanding of how sensory input is received, perceived, transformed, stored and retrieved. It is generally assumed that people with disabilities and learning problems have deficits in these cognitive processes.

The behaviourist model has greatly influenced the stimulus control and contingency management methods, precision teaching, mastery learning, direct instruction and computer-assisted instruction methods. Stimulus events such as screen prompts and accurate feedback are used to control the behaviour of students [6].

2.1 Cognitive and metacognitive training method

Generally, students with special needs have been described as passive learners [18]. Passive learners tend to attribute their successes or failures to forces over which they have little control (ability/luck), rather those they can control (effort/strategies). Passive learning can be caused by poor metacognitive knowledge, metacognitive control or motivational problems. Self-monitoring has been successful in promoting active learning [11]. Self-recording of the target event usually follows self-monitoring. The cognitive and metacognitive training method encompasses a similar approach to that of the stimulus control methods. Initial support is given, but with the aim of gradually transferring control for learning over to the student. Initially, the teacher describes the desired strategic behaviours by thinking aloud. Students imitate this by speaking aloud to guide their own thinking processes. Overt speech is gradually faded to covert speech so that the strategy may be internalised by the student. These methods have effectively taught behavioural, academic and interpersonal skills. After training, students may need to be prompted to use the learned strategies.

2.2 The stimulus control method

This method has had a profound impact on special education, but is seldom used in general education [6]. It manipulates antecedent events to encourage desired changes in learning or behaviour. The constant time delay (CTD) procedure is relatively simple to modify and highly effective. It has been used successfully with a wide range of disability types [20].

The initial series of trials in a CTD procedure contain a zero time delay. A task direction is given and the answer follows immediately. Subsequent trials use a fixed time interval for the control prompt. The best stimulus for the prompt for each set of tasks should be carefully selected at the design stage. Prompts can be gestural, verbal, pictorial, model actions or partially/fully physical. The CTD procedure has been successfully applied in CAI. It has been argued that the CTD procedure be used as a programming principle in the design of CAI for classified students. This would be equally valid for multimedia computer-assisted instruction (MCAI). A variation of delay intervals and presentation screens at strategic points during skill acquisition could be the subject of future research [7].

2.3 The VAKT method

This remedial method is also known as the Fernald method. It stipulates precise procedures for presenting stimuli and defines required responses from students. Prompts are gradually faded until students can learn the subject content without supports. At the beginning of the lesson, the student reads text out loud to the teacher. If a word is incorrectly pronounced or is not recognised within a reasonable time period, then it is recorded as an error. A multisensory procedure using visual, auditory, kinaesthetic and tactile stimuli attempts to correct the error. The teacher writes the correct word in large print and traces over the word whilst reading the word out loud syllable by syllable. This these actions. Lastly, the written word prompt is removed. The student then has to write the word and read it. The procedure is repeated until there are no errors. This method is really a combination of stimulus control and is done almost simultaneously. The student imitates multisensory strategies [6].

3. The Learning Environment

Let us assume that the knowledge to be taught has been selected and the course materials have been drafted. We now know *what* we will teach. The problem is, *how* will we teach it? At this stage, it is critical that the course materials be formulated to meet the student's special needs. The criteria for selecting teaching methods and strategies should be student-centred, rather than dependent upon the teacher's own preferred teaching methods.

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The primary concern should be to determine the capacity of the classified student. The current scope of the student's skills and abilities needs to be identified. Then there are aspects of different learning styles, such as preferred stimuli and required adaptive devices for handicaps. These should be contemplated within the identified scope of the students skills and abilities. Analysis of the skills, abilities and learning style aspects will impact upon the instructional design for each stage of learning in the learning environment.

3.1 Skills and abilities

Skills, deficits and preferences in the following areas will have a primary impact on the learning development of classified students. These factors need to be considered in the instructional design:

- **Psycho-motor skills** are a combination of visual perception and fine motor skills, eg. drawing a square.
- **Sensori-motor skills** are a sensory experience combined with a motor response, eg. moulding dough.
- **Visual perception** is the ability to discriminate and categorise visual stimuli into meaningful patterns.
- **Auditory perception** is the ability to discriminate and categorise auditory stimuli and detect their patterns.
- **Cognitive skills** are ways that students encode, organise, interpret, store and process incoming information.
- **Metacognitive skills** are the conscious knowledge and control of our own cognition [6].
- **Exceptional abilities** can occur in classified students such as superior visual-spatial perception [10].

3.2 Learning styles

Learning style can be defined as the way in which a student learns best [9]. Learning strategies may be learned and developed. By contrast, learning styles are static and are relatively in-built features of the individual [14]. Adaptive devices for handicaps are part of the classified student's learning style. There may be preferences for different temperature levels, lighting and noise in the learning environment. Different levels of motivation and interest will be present. Some learners are more analytical and can pick out embedded elements contained in information (field-independent). Others prefer to be given concrete examples (field-dependent) [14]. The type of preferred stimuli, such as visual, auditory, kinaesthetic and tactile, to support each stage of learning needs to be identified [16].

3.3 Stages of learning

Generally, a student's performance can be conceptualised as occurring in three main stages:

- **Acquisition:** At this stage the basic skills and facts are acquired. Acquisition can be reinforced by a variety of presentation modes, such as speech, text, visuals, movement.
- **Fluency:** Drill and practice are vital to attain accuracy within a time frame. CAI has a proven record in this area [6]. It is able to deliver self-paced lessons.
- **Generalisation:** Generalisation occurs when there are correct responses in settings other than the training setting. This has been an especially difficult stage for students with intellectual disability or severe handicaps [9]. Training should include a systematic change of teachers, setting, materials, cues and reinforcers. Target stimuli should be as close as possible to a naturally occurring stimulus. An audio prompt of the sound of a telephone ringing is a natural stimulus when teaching telephone techniques. Research indicates that MCAI promotes a higher level of generalisation than traditional paper cases [13].

4. Multimedia for Special Educators

Multimedia in education has been described as student-centred, project-oriented and as amenable to collaborative learning. Interactive multimedia can be defined as the simultaneous use of data in different media forms, such as voice, video, text, graphics, animations, virtual reality [3]. The interactivity afforded by multimedia can facilitate more than one teaching method or strategy to optimise learning. Advances in compression and decompression techniques mean vast amounts of multimedia can be stored on optical disks. Faster read access from CD-ROM drives means speedy retrieval of large multimedia data linked to multimedia software. Developments in virtual reality are rapidly moving towards realistic three-dimensional forms. Some overall benefits of multimedia software for classified students have been identified:

- They are highly motivated to engage in learning via a multimedia system.
- Properly designed software can assist them with cognitive and metacognitive strategies.

- Undetected intelligences and skills, eg. visual-spatial were identified when working with multimedia.
- There is an increase in self-esteem.
- Multisensory nature of MCAI facilitate learning.
- Motion and interactivity holds the student's attention.
- Software is consistent and eternally patient [10].

4.1 Retention and recall

Students with disabilities often have difficulty organising and retrieving information. They need to be shown techniques which will support retention and recall. One technique is to cluster similar material into small chunks. This assists in encoding information ready for storage in long-term memory. Another technique is to verbalise a word whilst viewing it [12, 17]. Many researchers support the view that the use and delivery of multisensory information contributes to more effective learning. A combination of media, such as simultaneous audio-visual stimuli assists recall and leads to better retention. It is often said that we remember two-thirds of what we both see and hear.

Sound offers many possibilities. It can be a second or alternative channel of communication. It can be a stimulus. Narration can be used instead of long sections of on-screen text. Special sound effects can augment visual and narrative information. The visually-impaired can be assisted by screen readers that read text from the screen. Interviews with experts in a field can stimulate interest in a subject. Speech can be used to explain technical information. Speech synthesis technology enables the computer to deliver verbal models. Prompts can be paired with printed words and graphics that appear on the screen [5]. Music is effective for setting the pace or prompting the user. Voice recognition systems that dictate instructions to the system can be trained.

Multimedia together with videotapes or videodisc can provide and support tutorials, drill and practice, sensori-motor skills and simulation all in the one program. A meta-analysis of 63 studies that used interactive video instruction reported a positive overall effect size for interactive video (IV). This was slightly higher than previous effect sizes reported for CAI. This result reinforces the belief that the ability of multimedia or IV to depict real-life situations has an added effect for learning outcomes. Further, students who have difficulty relating to a graphical representation of a situation may recognise the pertinent elements if presented in a realistic video format [19]. Videos of case studies or interviews with experts are an inexpensive and effective way of assisting students to transfer their skills and knowledge to a real-world setting [2].

4.2. Conceptual model of multimedia system for classified students

It is necessary to have a conceptual model of how to multimedia elements can assist in the stages of learning [1]. Inevitably, the overall design of any multimedia system will reflect a philosophical viewpoint concerning cognitive development. But, there is nothing against combining elements from the various cognitive theories into the system [8].

In the past, multimedia authoring was restricted to developers with computing or artistic expertise. Current authoring software hides some of these complexities from the developer, and there is an abundance of ready-made multimedia resources. Still, it is not simply a matter of slotting in visuals and sounds to embellish the content. In fact, research has shown that overstimulating can inhibit normal functioning [6]. It is the quality and sequence of relevant inputs that is important, not the quantity.

The multimedia designer needs to begin with an established framework from which to view the overall project. Experience with the capabilities of authoring programs is essential. Strategies specified by the special education consultant need to be integrated into the design. Additionally, the multimedia designer will need to consider the ergonomic factors and user input interface for students with a diverse types and ranges of disabilities. So, knowledge of various kinds of user interface adaptive techniques and devices is essential. When the designer produces a multimedia document, the following guidelines should be considered:

- **Natural terms**

The multimedia document should use terms and metaphors which are familiar to the students. Some system-oriented terms may discourage the use of this system by the students.

- **Clarity and consistency**

The overall multimedia document should be clear and consistent so that the students do not get confused.

- **Easy to navigate**

Students should know where they are in the program and, if needed, how to leave the unwanted state without any embarrassment.

- **Recognition rather than memorisation**

The student should not have to remember information from one part of the document to another. Objects, actions and options should be easily recognisable.

- **Flexibility**

There should be an appropriate level of flexibility, so that target learners can search for information according to their learning style and cognitive ability [1].

- **Easy help system**

The students sometimes need to get help from the system. For example, the balloon help system on Macintosh seems to be acceptable, if it includes other media types such as sound.

The following model shows a multimedia system for special education within a regular teaching setting, Figure 1. The classified students are assessed prior to receiving instruction through the multimedia system. This valuable information is provided by the special education consultant and has considerable influence on the design of the system. However, further screening via the start-up screen in the multimedia program, may also be appropriate. For instance, metacognitive abilities, sound or visual sensitivity could be assessed and depending on the results, appropriate action could be taken.

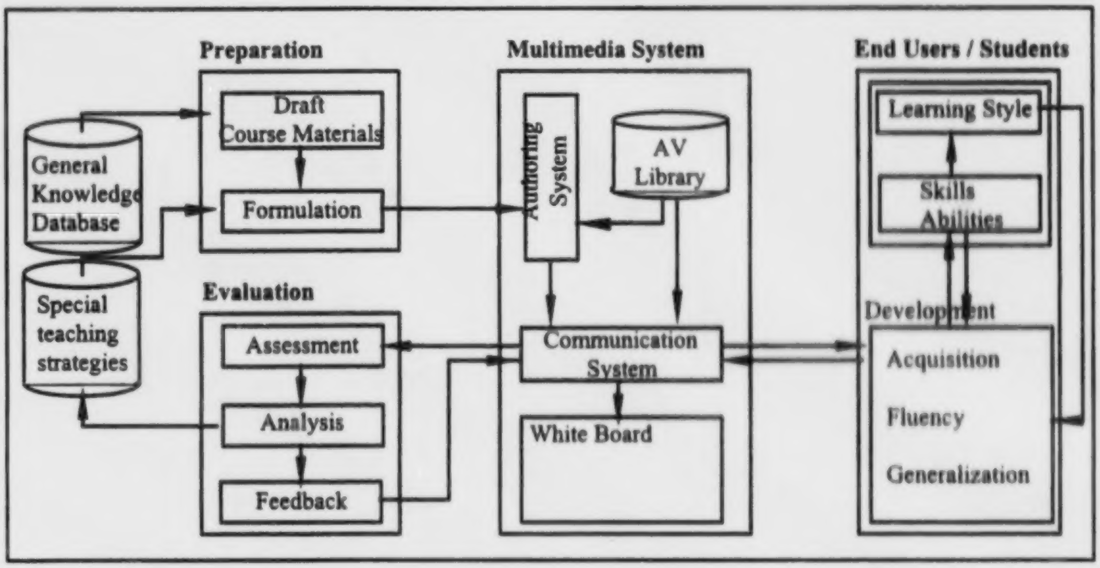
Preparation
Multimedia System
End Users / Students
Draft Course Materials
General Knowledge Database
Formulation
Authoring System
AV Library
Learning Style
Skills Abilities
Special teaching strategies
Evaluation
Development
Assessment
Communication System
Acquisition
Analysis
Fluency
White Board
Feedback
Generalization

Figure 1. Conceptual model for multimedia system.

4.2.1 Preparation of course materials in the subject domain

Initially, general knowledge about the subject domain will be extracted from the general library collection and databases. This knowledge is analysed and synthesised into draft course materials.

During formulation of these materials, the special education consultant will participate by selecting the appropriate teaching strategy according to his/her expert knowledge of the classified student's Individual education profile (IEP). The materials are then restructured to incorporate the chosen strategy. The document is annotated with detailed specifications of the steps in the teaching strategy. For example, to incorporate the constant time delay procedure, details of time delays and type of prompts should be inserted at points in the text. These course materials are forwarded to the multimedia designer for design and implementation into the multimedia system module.

4.2.2 Multimedia system module

This module transforms the educational information into various forms of multimedia such as graphics, animation, video clips and sound. It supports interactivity so that the students can easily interact and navigate the visible, audible and/or sensible information. Tasks of this module are handled by the multimedia designer with guidance from the educator. The designer is required to grasp effective multimedia techniques and artistic skills to manipulate the various media types. The multimedia document can be transmitted in synchronous or asynchronous mode depending on the needs and hardware available.

4.2.3 End users / students

The classified student interacts with the multimedia program by responding to prompts, highlighting text, choosing images, typing notes to the screen and answering questions. Adaptive input devices, as prescribed by the special education consultant, interface with the multimedia system for input and output. The student may need to access a database to search for various multimedia materials. Drill and practice and self-monitoring will be provided, where appropriate. The student can also create an audio or video clip and send it to the regular educator for analysis and corrective feedback. These interactions will contribute to the development of the student.

The capacity of the classified student will impact upon how well they process the information. Their capacity to learn is effected by their skills in psychomotor, sensorimotor, visual and auditory functioning, cognitive and metacognitive skills and exceptional abilities. Some learning style aspects such as motivation and interest level and preferred type of stimuli will also have an influence.

The classified student can communicate with their peers and the regular educator by posting queries on the whiteboard in the multimedia system. They can also send files containing results, graphs and case studies for marking and corrective feedback from the regular educator. The communications will also shape the development of the student.

In turn, the progressive learning development of the student, will have an effect on the development of their skills and abilities. Cognitive and metacognitive skills could improve as a result of strategic instruction in the multimedia program. As stated previously, learning styles are static and relatively in-built features of the individual. However, there could be indirect effects. If metacognitive skills are developed through instruction, then this could lead to a higher motivational level in their learning style.

4.2.4 Evaluation module

During the interaction with the students, affective outcomes such as satisfaction with the program can also be evaluated by the regular educator. After evaluation, the regular educator will compare the progress against the student's IEP and expected learning, analyse same and prepare a progress report for the Special Education Consultant (SEC). The regular educator and the SEC will confer to reach a consensus as to next step in the instruction program for the classified student.

The SEC then makes a decision as to the next step in the classified student's education. If the student has not made expected progress, then the SEC will select another teaching strategy and the instruction can then recommence according to the SEC's recommendations.

5. Conclusion

Different teaching strategies were investigated and analysed to pinpoint their suitability for transfer into a computerised system. Stimulus control methods require precise timing and repetitive actions and suit the strong capabilities of the computer to provide precision and reiterative looping. Auditory and visual prompts can be inserted at strategic points to support these methods. Similarly, the audio and visual capabilities of multimedia systems can facilitate multisensory learning procedures as described in the VAKT method. Cognitive and metacognitive training methods are structured and can be implemented through multimedia.

Some learning skills and abilities were described. Motor skills and visual / auditory perceptive skills can be enhanced through multimedia. Deficits in these skills can be assisted by using alternative approaches for multimedia presentation. Evidence was gathered about other benefits of multimedia for classified students. This information reinforced the belief that multimedia can have affective outcomes such as increased motivation and self-esteem. It also has potential to assist in retention and recall.

On this foundation, a new conceptual model was constructed for special education in a regular educational setting using a multimedia system module for delivery of the learning material. Interaction between the regular teacher and classified student is supported through the multimedia system, whilst retaining the expertise and support from the special education consultant.

Flexible learning can be more cost-effective than conventional modes of education, if the support infrastructure, such as courseware, equipment, and databases, is already in place. The initial set-up expense for this infrastructure is largely a one-off expense. The teaching strategies are contained within the multimedia program. This reduces the need for additional on-site specially-trained staff. Therefore, there is a reduction in recurring expenses. There is also a degree of self-instruction, self-assessment, self-monitoring and self-pacing in the multimedia system module. Interaction with the teacher is flexible. There is less requirement for a teacher to be continuously present for instruction. This decreases the demands on teacher time.

On the other hand, many staff members may not feel empowered by computer technology. As with any computer delivery system, reliable technical support is crucial to overall satisfaction with the system. Special education has been characterised by the higher level of support needed. Regular educators will need some training in special education, so that their interaction with the classified students is not impeded. The selection criteria for regular educators involved in this model will need to include specific personal characteristics which are needed in the special education area. Some examples are patience, persistence, high dedication and perception of special needs. At times, regular educators will need to communicate and consult with the support team consisting of special educator, physiotherapist, occupational therapist and other specialists in this field.

The purpose of the suggested model has been to address the pressures upon the regular education sector to meet the learning needs of classified students within reasonable budget parameters. The model could be extended to include other forms of flexible delivery modes such as the World Wide Web.

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Measuring Affective Aspects of WWW and E-mail Use in Course Delivery

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Abstract: This study has examined the effect on the level of anxiety of first year teacher education students after extensive course use of the WWW and E-mail. Two instruments were used. The first (the CAIN) measured student computer anxiety; it indicated that the WWW and E-mail experiences during the course had no significant affect on the level of computer anxiety for both genders. Student responses to a new instrument developed by the authors to measure computer-mediated communications (CMC) anxiety, administered at the completion of the course, were analyzed to determine whether CMC anxiety can be conceptualized as a unidimensional trait. The results indicated that 29 of the 34 questions in this instrument fell within the constraints of the Rasch model used. Hence, it is suggested that CMC anxiety can be considered as a unidimensional construct. Further research will generalize the CMC instrument as an evaluation tool.

Introduction

There are high expectations of teaching and learning with the World Wide Web (WWW) and e-mail, especially in higher education. In this era of financial cuts to higher education funding, it is hoped that the WWW and e-mail will: (i) provide cost-efficient and effective teaching mediums; (ii) reshape the conditions of teaching and learning; (iii) distribute access more equitably to potential students who are excluded on grounds of ethnicity/race, gender, disability, geography, and full-time work; and (iv) equip graduates for life-long learning in an increasingly technological world. Not surprisingly, there has been a proliferation of papers at conferences and in journals addressing various aspects of the utilization of the WWW and e-mail. Major recurring themes focus on programming tools, copyright, censorship, cognitive aspects of teaching and learning, and descriptions of the design and implementation of WWW subjects. There appear to be few studies measuring affective aspects of student learning using the WWW and e-mail.

[Levine 1994] argues that evaluation of computer-based programs should pay careful attention to factors such as the context into which they are introduced and students' perceptions of the learning environment. Such evaluations should include both cognitive and attitudinal data since success or failure of educational innovations is partly attributable to students' attitudes [Askar, Yavus & Koskal 1992]. [Goldfayl 1995] reinforces these claims, arguing that affective domain factors have largely been neglected by designers of multimedia materials and that they have undervalued the impact of affect on learning.

This paper reports on (i) the effect on computer anxiety of participation in a course that was predominantly delivered using the WWW and e-mail and (ii) the development of an evaluation instrument using Likert items to measure student anxiety towards the use of the WWW and e-mail, referred to in this paper as computer-mediated communications (CMC) anxiety.

Context

The Bachelor of Education program at James Cook University has a core first year subject, *Information Technologies in Education*, which, in 1996, was studied by approximately 170 students. Prior to 1996, the subject was taught in a traditional format of lectures and tutorial/workshops, the latter involved learning basic word processing, database, and spreadsheet skills. In 1996, the lecture material was delivered over a WWW-based Intranet. Three major reasons for this were: (i) cost effectiveness; (ii) relevance to a course on information technologies; and (iii) equity of access, particularly for those students who had full-time jobs.

Earlier unpublished research revealed a moderately high level of computer anxiety among members of a previous cohort of students in this subject whose exposure to computers was less than that of the current participants who had access to both computers and the WWW. Hence it was predicted that a lower level of computer anxiety would be manifest in the 1996 cohort of students as a result of their greater exposure to, and involvement with, computers, the WWW and e-mail.

Instruments

Computer Opinion Survey

The computer-anxiety measure used in this study was the Computer Opinion Survey [Simonson, Maurer, Montag-Torardi & Whitaker 1987] from which a score called the computer-anxiety index (CAIN) was calculated. The survey consists of 26 positively- or negatively-worded Likert-type items developed from a larger number of items that were considered indicative of a person's feelings of anxiety towards computers. The CAIN was found by [Simonson et al. 1987] to have an internal consistency reliability estimate of 0.94 and a test-retest reliability estimate of 0.90. Concurrent validity was tested by the authors of the test against the State portion of the State-Trait Anxiety Index (STAI). The CAIN was found to correlate significantly with the STAI score (r=0.32) as well as with a score based on the average of two observer's judgement of student anxiety when students were working with computers (r=0.36). The possible range of scores for the CAIN is 26 (26 answers of low anxiety value of 1) to 156 (26 answers of high anxiety value of 6), with higher overall scores indicating higher anxiety.

WWW/ E-mail Survey

The exploratory survey used as a measure of computer-mediated communications (CMC) anxiety consisted of 34 positively- and negatively-worded questions (Appendix 1) which formed, in this instance, part of a 72-item evaluation questionnaire administered to the sample at the conclusion of the semester-long course.

The questions in the 34-item set were considered indicative of a person's feelings of anxiety towards the use of World Wide Web and e-mail. The questions were dispersed throughout the evaluation questionnaire with a view to obtaining responses which could be analysed to see if a unidimensional construct, CMC anxiety, might be measurable.

Methodology

Students were administered the Computer Opinion Survey at the first session of the course as a pretest and also at the final session as a posttest. CAIN scores were obtained for the students' pre and posttests by reversing the responses for the negatively-worded questions and then adding the responses for each item.

In order to test the unidimensionality of the 34-item set of CMC anxiety questions in the course evaluation questionnaire, Rasch analysis was used [Rasch 1960/80]. Rasch analysis is a mathematical formulation which has recently been extended [Wright & Masters 1982] to handle Likert-type data. It is based on an Item Response Theory model and presumes that, in this case, it is the difference between the CMC anxiety of any person and the anxiety level of any item (its "difficulty" level) which determines the likelihood that any person will endorse any item.

The Rasch analysis enabled the students' response patterns to each of the selected set of anxiety questions in the evaluation form to be compared with their responses for all other questions in the set. Questions not demonstrating item-response patterns within 30% the expected values determined by the Quest computer program [Adams & Khoo 1993] were rejected.

The extent to which the anxiety questions conform to the estimations based on the Rasch model may be interpreted as evidence that all accepted items conform to the unidimensionality premise, that is, that all items measure the same latent trait, hopefully CMC, anxiety about the use of the WWW and e-mail. As part of the calculations to determine whether the unidimensionality premise had been satisfied, item difficulty levels and person "anxiety" levels were estimated by the Quest program. The requirement of unidimensionality of test questions is important in order that trait estimates (scores) can be meaningfully added to provide an overall estimate of CMC anxiety. It is argued that the use of Rasch analysis has direct applicability to this type of exercise where the responses to each item are to be simply added. The use of a factor-analytical model is regarded as being more appropriate when the particular construct is conceptualised as multidimensional; in this case, the raw scores for each factor require "weighting" according to the factor loading before adding the factor scores.

Results and Discussion

Computer Anxiety Results

Means and standard deviations for the group of students who were present for both testing times are shown in Table 1.

	Pretest		Posttest	
	Mean	Std. Dev.	Mean	Std. Dev.
Female (n=52)	57.00	18.12	57.15	21.70
Male (n=16)	48.56	14.34	46.50	17.36

Table 1: Pretest and Posttest Means and Standard Deviations for the CAIN Scores

A repeated measures ANOVA to look at gender differences yielded a significant gender difference as shown in Table 2.

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Gender	1	2229.76	2229.76	4.01	.049 *
Subject	66	36729.85	556.51		
Tests	1	4.60	4.60	.03	.872
Tests * Gender	1	30.05	30.05	.17	.681
Tests * Subject	66	11638.85	176.35		

* $p < 0.05$

Table 2: Repeated Measures ANOVA for CAIN Scores by Gender

Given that the possible range of CAIN scores is 26 to 156, it is clear that the anxiety level at the beginning of the semester for both genders was not high, although the mean for females was approximately 9 points higher than that for the males. On the posttest, this difference had increased to almost 11 points. However, this change was the result of a decrease in the mean score for the males rather than an increase in the mean for the females. It appears that the experience of the females in the course did not alter their level of anxiety and concern with use of the computer. On the other hand, the experience of the males appears to have lessened their anxieties and concerns to some degree.

The prediction that there would be a significant decrease in computer anxiety is not supported by the results in Table 2 ($p = 0.872$). While the literature generally indicates that computer anxiety generally reduces with increased previous experience with computers, other research has demonstrated that this is not always the case. Factors such as computer access concerns and type of software used have been shown to affect this result [King 1994-5]. Some of the written responses gathered with the 72-item questionnaire also indicated a lack of computer access which may have contributed to the maintenance of the initial level of computer anxiety.

CMC Anxiety Results

From the Rasch analysis of the data from the exploratory 34-item CMC anxiety survey instrument, it was concluded that at least five questions were not measuring the same variable as the remaining 29. That is, these five questions had unacceptably high indices of misfit to the model. The varying degrees of misfit of each of these five items compared to the requirements of the Rasch model are illustrated in Figure 1. Acceptable levels

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are indicated by the vertical dotted lines which indicate infit mean square values which are 30% above or below expected values. As a rule of thumb, items whose points fall outside these lines are rejected.

```
Item                    Infit Mean Square Value

    .63       .71       .83      1.00      1.20      1.40      1.60
-----+---------+---------+---------+---------+---------+---------+--------+
  1                 .              |              .*
  2                 .              *              .
  3                 .              |      *       .
  4                 .              |            * .
  5                 .*             |              .
  6                 .   *          |              .
  7                 .         *    |              .
  8                 .              |   *          .
  9                 .              |              .                  *
  10                .        *     |              .
  11                *              |              .
  12                . *            |              .
  13                .              | *            .
  14                .              |            * .
  15                .              |      *       .
  16                .              |      *       .
  17                .       *      |              .
  18                .       *      |              .
  19       *        .              |              .
  20                .   *          |              .
  21                .              |              . *
  22                .     *        |              .
  23                .              |   *          .
  24                .       *      |              .
  25                .             *|              .
  26                .        *     |              .
  27                .   *          |              .
  28                .    *         |              .
  29                .              *              .
  30                .              *              .
  31                .             *|              .
  32                .             *|              .
  33                .              |              .  *
  34                .              |        *     .
```

Figure 1: Rasch analysis output from Quest showing unacceptable misfit for 5 questionnaire items.

The five rejected items are listed below:
1. I did not access WWW lecture material on the WWW.
9. I used the WWW a lot before I started this subject..
19. I can think of many useful ways to use the WWW.
21. Links to other information from Web lectures caused confusion for me.
33. I was never anxious about learning from the WWW.

A number of reasons for the rejection of the above items can be hypothesized. Item 1 may have been rejected because both high and low CMC-anxiety students may have preferred the convenience of learning from a print-out of the WWW material rather than reading the material online. In relation to item 9, it is quite likely that both potentially high and low CMC-anxiety students may not have been able to obtain previous access to the WWW and, therefore, this question may have elicited similar responses from these two groups of students. As this and other first year university courses did not require them to look at other ways of using the WWW, item 19 may also not have discriminated between high and low CMC-anxiety students. The design of the WWW materials may have been the cause of confusion in item 21 rather than anxiety being a factor in this confusion. Use of the word, *never*, may have been the confusing factor in item 33 as even the low anxious students may have had anxious moments in learning from the WWW material at some point.

A further Rasch analysis excluding the five rejected questions still needs to be undertaken to determine whether the remaining 29 questions retain their unidimensionality.

Conclusion

This exploratory study has confirmed that this cohort of students who had comparatively low computer anxiety scores when they commenced this course, were not affected adversely by using the WWW for engaging with the lecture materials. Qualitative data not yet analyzed from the WWW/e-mail survey should help to clarify why the computer anxiety level did not decrease as was hypothesized earlier in this paper. This analysis may also help to explain the significant gender effect.

The use of Rasch analysis, in an attempt to develop an evaluation instrument measuring CMC anxiety, has resulted in a unidimensional set of 29 items. These may tentatively be used as an evaluation instrument for assessing the effect of the use of the WWW and e-mail for student learning. Further work, including a confirmatory Rasch analysis and generalizing some questions, needs to be undertaken.

Benefits arising from this study may include an efficient means of measuring affective aspects of student use of the WWW and e-mail. This may, in turn, help create a better balance between affective and cognitive concerns in this area.

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Appendix 1: WWW/E-mail survey

SA = Strongly Agree; A = Agree; U = Undecided; D = Disagree; SA = Strongly Disagree

		SA	A	U	D	SD
1.	I did not access the WWW lecture materials on the WWW.					
2.	I like being able to access linked WWW information from the Web lecture notes.					
3.	Navigating (finding my way) through the WWW lecture topics was easy.					
4.	I prefer WWW lectures to face-to-face mass lectures.					
5.	Future teachers really need to know about the World Wide Web.					
6.	There are many interesting things on the World Wide Web.					
7.	Future teachers really need to know about e-mail.					
8.	I will continue to use the WWW after this year.					
9.	I used the World Wide Web a lot before I started this subject.					
10.	The World Wide Web is not what it is made out to be.					
11.	The WWW has opened up a whole new area of communication for me.					
12.	Using e-mail makes me nervous.					
13.	The electronic discussion group was a good idea.					
14.	I contributed to the electronic discussion group.					
15.	I intended to contribute to the electronic discussion group.					
16.	I read what others wrote in the electronic discussion groups.					

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17.	I found having subject information available from a subject menu on the Web was useful to me.					
18.	Having to interact with Web materials on the screen was motivating.					
19.	I can think of many useful ways to use the World Wide Web.					
20.	I will continue to use e-mail after this year.					
21.	Links to other information from Web lectures caused confusion to me.					
22.	I feel happy working with the WWW lecture topics.					
23.	Using the World Wide Web makes me nervous.					
24.	I think that there is too much emphasis placed on the Internet at present.					
25.	Telecommunications will be an important part of my life.					
26.	If I could avoid using the World Wide Web, I would.					
27.	Life is easier for me now that I can use the WWW.					
28.	The WWW lectures motivated me to search in the WWW for further information.					
29.	If I could avoid using e-mail, I would.					
30.	Life is easier for me now that I can use e-mail..					
31.	Using e-mail is more of a nuisance than it is worth .					
32.	E-mail has opened up a whole new area of communication for me.					
33.	I was never anxious about learning from the WWW.					
34.	My anxieties about learning from the WWW lessened during the semester.					

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Multi-user Interactive Concept Maps for the Learning Web

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Abstract: Concept mapping applications can be embedded in the standard Netscape Web browser that allow several types of interaction among instructor and students. The range of interaction includes instructors posting structured information for later perusal by the students; "live workspace" remote lectures; remote interactive lectures; remote instructor observation and immediate correction of students' work; and remote collaboration among students. The concept mapping applications described here form a valuable tool in the learning web approach to education, described at previous ED-MEDIA conferences.

Introduction

Concept maps are graphs consisting of nodes with connecting arcs, which represent relationships between nodes [Lambiotte et al. 1984]. The nodes are labeled with descriptive text, representing the "concept", and the arcs are often labeled with a relationship type. Nodes may be represented using distinct visual attributes, such as shape and color, to distinguish node types; arcs may be similarly distinguished.

[Fig. 1] shows a concept map about whales by a first grade student. The arcs on the map are labeled with the relationship they represent: "EAT", "HAVE" and "ARE". The student was originally taught to do concept maps on paper without labeled arcs. He enthusiastically adapted to the software version and became quite at ease with labeled arcs after only minimal instruction.

Individual authors (both students and instructors) can compose concept maps to conveniently convey non-linear information structures, but *groups* of authors may also benefit from this flexible form of knowledge representation. Of course, software designed for groups, rather than for individuals, requires special attention [Grudin 1991] [Cockburn & Thimbleby 1995]. Besides the obvious need for the information to be placed in a repository conveniently accessible to all participants, various issues arise concerning participant awareness, security, data integrity, and role assignment. This paper will address one approach to the problem of designing software for use by groups: Concept maps are cast as interactive multimedia objects on the Web which can be embedded within HTML documents. Furthermore, the Web's usual distinct roles of authorship and readership are merged to produce a model of *participantship* which allows continuous incremental authoring of concept maps within Web documents — which have been traditionally regarded as fairly static. All of this may seem a bit abstract; so, several applications which exemplify this style of concept map use on the Web will be described.

Concept Maps on the Web

The Web is a useful and valuable tool to support the learning web [Gaines, Norrie & Shaw 1996] approach to education [Shaw & Gaines 1996]. Concept mapping tools can augment the standard Web tools to further support the learning web approach. This section and the next section describe several concept mapping tools which can be embedded in the standard Netscape Web browser.

The current version of the Netscape WWW browser allows concept mapping programs, written in C++, to be cleanly integrated with the browser such that users can interact with the concept map as easily as they might interact with a clickable image. Concept maps can be used just as though they were native objects to the

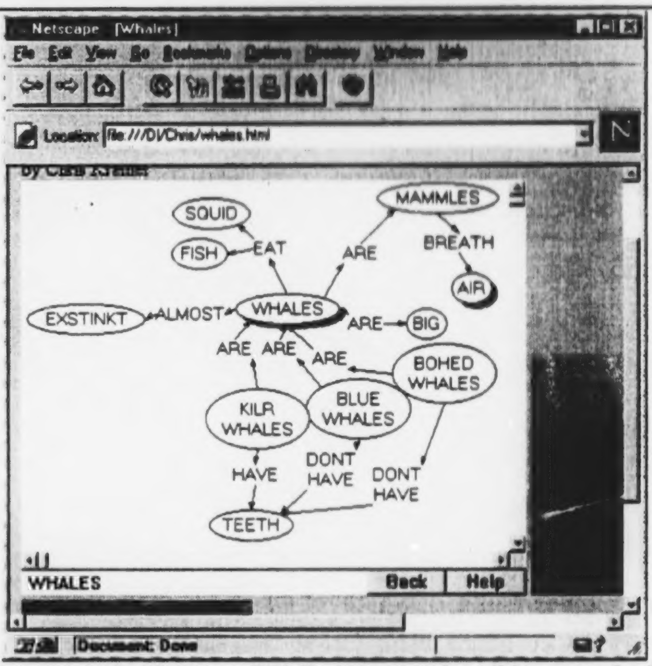
Netscape - [Whales]
File Edit View Go Bookmarks Options Directory Window Help
Location: file:///D|/Chris/whales.html
SQUID
MAMMLES
FISH
EAT
ARE
BREATH
AIR
EXSTINKT
ALMOST
WHALES
ARE
BIG
ARE
ARE
ARE
BOHED WHALES
KILR WHALES
BLUE WHALES
HAVE
DONT HAVE
DONT HAVE
TEETH
WHALES
Back
Help
Document: Done

Figure 1: A concept map embedded in an HTML document describing part of a C++ class library.

browser program. [Fig. 1] shows a Smart Ideas [Smart Technologies Inc. 1997] concept map embedded in an HTML document. This document and concept map are a student's report on whales. The concept map is actually a local hypertext of maps which can be navigated within its picture frame. The status bar just below the map contains the map's name within the local (within frame) hypertext, as well as a local "back" button for local hypertext navigation. The concept map itself can be re-arranged by simple direct manipulation commands. Nodes and arcs in the map carry visual attributes to indicate their type. Drop-down shadows on nodes indicate that the node may be clicked to navigate either to another local map (within the current document), or to a different Web document.

All this is possible through the *plugin* Application Program Interface (API) provided by Netscape. Plugins are programs which register themselves with the Netscape browser in association with a specific MIME type [Borenstein 1993], and are dynamically loaded by Netscape whenever an object of that MIME type is displayed. Plugins can be either embedded in an HTML document or displayed as complete documents themselves. Plugins may also interact with the Netscape browser and with the enclosing HTML document such that the plugin may affect changes to the HTML document (including other plugins). Likewise, interactive elements (such as buttons) in the HTML document may send messages to the plugin. [Fig. 2] shows a KSIMapper [Kremer & Flores-Mendez 1997] concept map embedded in an HTML document which contains many objects which interact with the concept map. A similar program, written as a Java applet, has also been constructed and described in these proceedings [Flores-Mendez 1997].

Groupware Aspects

While concept maps can be very useful as Web documents, their usefulness can be dramatically increased by making them multi-user interactive documents. That is, the traditional distinctions between document author and reader (instructor and student) can be dissolved to create a *participant* role, where (sufficiently privileged) individuals can not only browse a concept map but also change the document and store the modified document back to the server. Furthermore, if two or more users happen to access a particular document at the same time, they should be able to smoothly move into a synchronous shared editing session. The simple interaction

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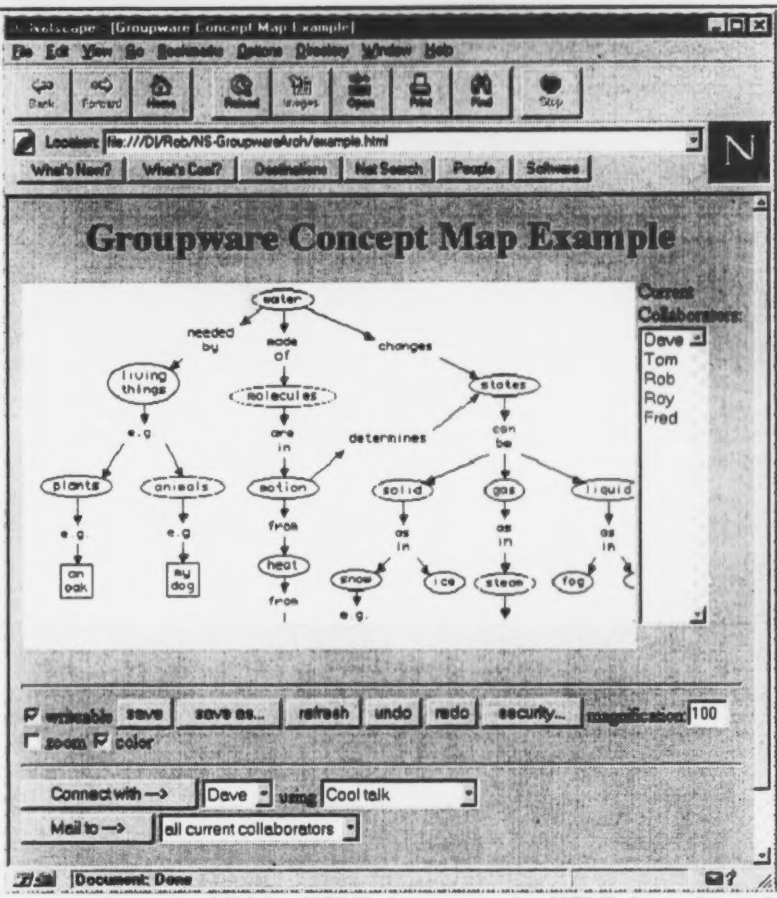
Netscape - [Groupware Concept Map Example]
File Edit View Go Bookmarks Options Directory Window Help
Back
Forward
Home
Reload
Images
Open
Print
Find
Stop
What's New?
What's Cool?
Destinations
Net Search
People
Software
Groupware Concept Map Example
water
needed by
made of
changes
living things
molecules
states
e.g
are in
determines
can be
plants
animals
motion
solid
gas
liquid
e.g.
from
as in
an oak
my dog
heat
snow
ice
steam
fog
save
save as...
refresh
undo
redo
security...
Connect with -->
Mail to -->
Document: Done

Location: file:///D|/Rob/NS-GroupwareArch/example.html

Current Collaborators: Dave Tom Rob Roy Fred

☑ writeable ☐ zoom ☑ color magnification: 100

Connect with --> Dave using Cool talk

Mail to --> all current collaborators

Figure 2: A concept map embedded in a HTML document using HTML forms input elements and JavaScript to achieve a custom user interface.

architecture outlined here allows any number of users to interact. This "free and easy" mode of peer interaction is critical to support the learning web model of education.

Allowing users to update concept maps from a Web browser is accomplished through use of the CGI (Common Gateway Interface), available on most WWW servers. A shared concept map is not directly referenced by its normal URL; instead, a custom CGI program is referenced, and this reference is parameterized with a reference to the actual concept map document. When the URL is fetched by the client browser, it is the responsibility of the CGI program to return the concept map data on behalf of the server.

When the client wishes to save the concept map, the same indirect URL is used, but with the concept map data as part of the *post* message. The CGI program is called by the server, and the CGI program copies the data back into the original file on the server.

Of course, this simplistic approach is open to malicious or accidental disruption of the data. A host of security issues come to mind. While these issues have not been addressed so far in this research, there are many well-tested solutions elsewhere. Version control, which can be as simple as maintaining a new version of a file every time it is written back to the server, is one approach; public-key encrypted electronic signatures being verified on a write-back is another.

Merely allowing users to write concept maps back to the server is not enough. Besides the obvious dangers of users overwriting each others' work, users need to be kept aware of other users concurrently accessing the

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concept map and what the other users are doing. Each user's concept map must also be synchronized so that all users are observing the same map.

Since shared concept map access is through a server CGI program, this program can take responsibility for recording access as part of the concept map's history, and for coordinating "real time" interaction between concurrent participants. Thus, clients can obtain information about past and current participants from the server (as in [Fig. 2]). Furthermore, since the software architecture uses *command objects* [Gamma et al. 1995] to encapsulate all user updates to a concept map's state, these command objects can be sent to the server where they can be re-broadcast to all concurrent participants. In this way, each of the participants will receive all participants' commands, and all participants' concept maps will eventually arrive at the same state. (There are many finer points to this kind of interaction, but they will not be discussed here.)

This form of interaction has the advantage of being serendipitous; that is, users need not go to any special trouble to set up a "conference"; instead, interactive sessions are automatically set up by virtue of concurrent access to the same concept map. This not only avoids the complex "conference setup" of many groupware tools, but also supports a natural *places*, or *rooms* metaphor — participants can serendipitously meet other participants at some location (Web page) or may specifically arrange to meet at a certain location (Web page) at a certain time. See [Roseman & Greenberg 1996] for a discussion of this kind of interaction.

Application

As already mentioned in the introduction, concept maps' flexibility allows for a variety of applications within the educational field. This section describes several applications where Web-based concept mapping tools, in particular, can be used.

"2½-d" Guide To Information Objects

If one ignores the groupware possibilities and follows a more traditional instructor/student model of Web authoring, concept maps can play a role on the Web very similar to that of clickable images. An instructor designs and constructs a concept map off-line, then posts the finished product on the Web; students do not have any ability to modify the artifact. [Fig. 1] is an example of this sort of "read-only" Web concept map. Although students cannot change the map permanently, they can perform certain actions, as prescribed by the instructor, such as clicking on a node to navigate to other information.

In the case of Smart Ideas concept maps, which encapsulate a local hypertext of concept maps, the instructor has a choice of a node either being a hyperlink to another Web document or being a local hyperlink within the local hypertext of concept maps. In the later case, the Web document remains displayed; only the sub-window in which the concept map is displayed gets replaced by the new map. A local "back" button helps to maintain the students' context by providing the ability to backtrack.

Typically, well-written Web document collections use lists of links as a "table or contents" to aid readers as they navigate through the material [Tilton 1995]. Concept maps can be used to the same end. Rather than a simple table of contents list, the reader can be presented with a concept map describing the document collection. The reader can then click on the concept map nodes to navigate the site. In this scenario, the nodes represent possible destinations in the information space, and arcs represent the relationships between them. Concept maps have an advantage over simple (or even hierarchical) lists in several areas:

- Concept maps can convey *structure*. That is, besides the sequence and hierarchy that lists can display, concept maps can visually display cycles, containment, and other complex structures.
- Concept map links can be typed (labeled or otherwise visually distinguished) to make *relationships* among the nodes explicit. Lists have no means of displaying relationships among elements other than simple sequence and generic hierarchy.
- Concept map nodes can be visually typed (by surround shape, color, and style) to convey quite a bit of information to the student experienced in reading a particular style of concept map. For example, a concept

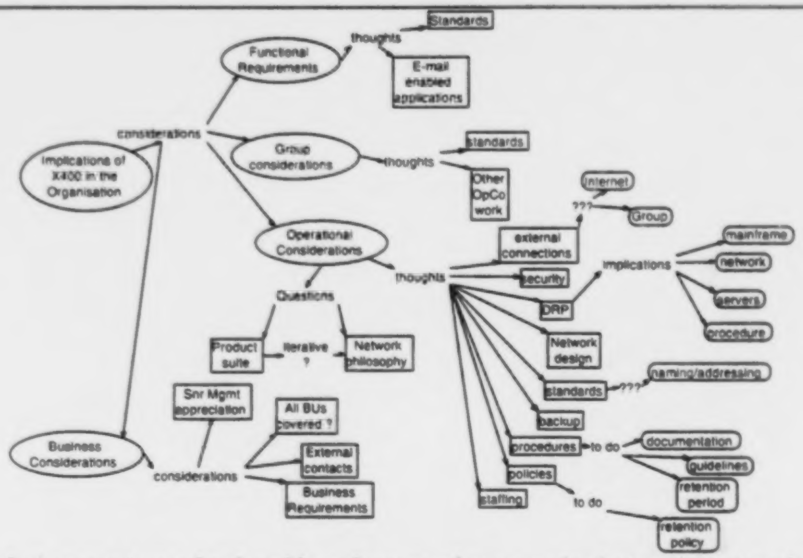
Standards
thoughts
Functional Requirements
E-mail enabled applications
considerations
Implications of X400 in the Organisation
Group considerations
thoughts
standards
Other OpCo work
internet
???
Group
Operational Considerations
external connections
mainframe
implications
network
thoughts
security
servers
DRP
Questions
procedure
Product suite
iterative ?
Network philosophy
Network design
standards
???
naming/addressing
Snr Mgmt appreciation
All BUs covered ?
backup
Business Considerations
External contacts
procedures
to do
documentation
considerations
guidelines
policies
retention period
Business Requirements
staffing
to do
retention policy

Figure 3: A concept map developed by a three member group brainstorming network design [Kremer 1993].

map of a programming structure can use shape and color to distinguish various object types such as *library, function, class, abstract class, concrete class, exception class, file, source file,* and *macro.*

Concept maps suffer from their tendency to take up more precious screen real estate than lists, but often this can be mitigated by scrolling and nesting maps.

Presentation Planning

Traditional hierarchical outlining techniques force authors into a great deal of premature planning. Hierarchical outlines force an early decision on the order of presentation. Furthermore, complex non-hierarchical relationships that may be inherent in the material may be difficult to represent in the outline. Both of these problems are neatly solved by use of concept maps: Points can be listed as nodes without inherent order; and complex relationships between them are represented naturally and easily by arcs.

It should be noted that, even after the construction of a complete concept map of a particular topic, one must *still* "linearize" it if the topic is to be presented in more traditional medium, such as a paper or a talk. Concept mapping gives the author a convenient intermediate point to bridge between raw ideas and an organized, linear presentation.

Brainstorming

Concept maps are good tools for student brainstorming sessions. The scenario here is a group of learning web students working together on a project. The nodes and arcs act as concrete symbols for ideas, and the arcs allow one to draw complex relationships among them, arranging, comparing, contrasting, and grouping ideas. Concept maps can be used for brainstorming by groups of students for planning projects, "outlining" papers, or assembling presentations. [Fig. 3] is an example of a concept map developed during a group brainstorming session on the design of a computer network.

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Observation and Interaction

The real-time interaction facility of Web-based concept maps allows instructors and students to interact, even when they are not in the same location. Assuming a second communications channel for audio, teachers may give instruction with full illustration though the shared concept map as a work surface. The concept map may be pre-existing or may be developed over the course of the instruction. In either case, the "live" surface allows for detailed extension, pointing, gesture, and animation. Furthermore, depending on the situation, students may be allowed to extend and modify the concept maps during the instruction.

Reversing the roles, students may develop a concept map as the instructor observes from a remote station. Errors made may be immediately corrected by the instructor, since the instructor can have full access to the work surface. This flexibility is ideal for the learning web approach to education.

Summary

Concept maps are an intuitive form of knowledge representation. While concept maps are useful for traditional presentation, their utility can be enhanced by making the concept mapping tools multi-user tools. As such, maps are stored in a central repository where instructors and students could read, edit, and update them: an ideal technology for use in the learning web approach to education.

In this approach, data integrity is simply and naturally maintained by allowing multiple users to interact in real-time whenever more than one user accesses a particular concept map. That is, each user's map is always up-to-date because every user's state-changing activities are broadcast to all the other concurrent users of the same map.

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"Media +" - A Multimedia Environment for Constructionist Learning.

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Abstract: A learning environment based on constructionist approach is presented. "Media+" supports learning that is directed towards construction of an external product. Construction is carried out using a multimedia authoring tool. Learners engage in independent study of a subject, they form their own leading theme for researching and learning their subject, they plan, design and construct a multimedia presentation which reflects their grasp of their subject. A special emphasis is placed on encouraging and instructing teachers in adopting the new role required by the environment. Students and teachers participate as equals in evaluating the students' achievements in all facets of learning. Preliminary evaluation shows that significant learning takes place in "Media +" classes, including features which may be attributed to constructionist learning. "Media +" is implemented in 60 classes in middle schools in Israel. In 1997 80 teachers will join the project after having received a full year preparation course.

"Media +" is the name of a multimedia environment designed for supporting a constructionist approach to learning. "Media +" was developed and is being implemented in schools all over Israel by IDEA[1] center. In this paper we describe the environment, explain how it supports constructionist learning, and describe the role multimedia play in this process. Finally we show how the environment is implemented in a middle school science class, and present data to show the occurrence of meaningful learning in this class.

The constructionist conception of learning advocated by Papert [Papert, 1980] assumes a central role for the construction of an external product that can be shared with others. Papert emphasizes the product being external to the learner, in order to distinguish it from the constructivist concept of learning as an internal process. In radical constructivism, learning as the construction of mental schemes is an exclusively internal process [Glasersfeld, 1995]. As such, it is accessible to others only indirectly. When guiding the learner to construct some external expression of learning, an element of communication is involved, which permits a less indirect awareness of others to the fact that something has been learned. The distinction between constructionism and constructivism is crucial to anyone whose main concern is with the application of learning theories in the classroom. Within a constructionist approach, we can visualize a working model that incorporates both internal processes of constructing knowledge, and external influences of the surrounding context. We require a working model that permits multi-lateral communication involving both teacher and fellow learners, assigns a distinct role for the teacher, and lays down a basis for evaluating various facets of learning that occurs within its framework. A working model based on the constructionist conception enables us to foster an interplay between internal and external learning activities that is expected to promote mental creative activity [Shaw, 1996]. "Media +" was designed as an environment conducive to active and creative learning.

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Conceptual Guidelines for the Environment

The environment was designed on the basis of some general assumptions concerning the process of learning. We assume (with many others) that meaningful learning occurs if:

1. the learner is free to construct her/his own perception of the information brought to her/his attention;
2. the environment stimulates curiosity, permits free choice and independent study, and supports self-motivation;
3. the environment supports learning through creative processes;
4. the environment is free from irrelevant or intimidating interactions which stifle the natural curiosity of the learner.

With these assumptions to guide us, the learning environment was designed. Its main features are:

1. Learners choose a central theme for their independent study within a given subject.
2. Learning is centered about the construction of a product, a computerized multimedia presentation.
3. Learners make their own decisions and choices when constructing the presentation, so that it reflects the insights and knowledge gained by them throughout this process.
4. Learners achieve mastery of the multimedia tools as they proceed with their design and construction of the presentation..
5. Learners participate as equals with teachers in evaluating their own performance.
6. Learners are encouraged to work in teams, to exchange interesting findings, to share ideas, and to discuss problems and possible solutions.
7. Teachers assume a role of guidance and assistance, and are taught to encourage their students to share responsibility for their learning.

A General Description of Learning in the Environment

Learners are aware of an objective - the construction of a multimedia presentation - from an early stage of their studies. Most learning activities are motivated by needs that arise out of the process of construction. The learner gathers material, conducts research, organises and processes information in a way which would best express her/his gradually developing ideas. Throughout the process, the learner implements cognitive skills of information processing, classification, rational selection, problem-solving and decision-making.

In addition, the learner is encouraged by the teacher to form her/his conception of the appropriate way to evaluate her/his own work, and to offer parameters that will be relevant for evaluation. Self evaluation may occur continuously, or at specific intervals determined by the learner during the period of learning.

The construction of a multimedia presentation adds tasks of expressing and presenting information and ideas in a non-verbal form. Our assumption, to be tested by further research, is that the use of multimedia fosters additional cognitive skills, not normally activated in a classical text-based learning environment. Thus we consider that "Media +" introduces a use of the computer as a pedagogic tool [Salomon, 1993]. Some preliminary findings point to the possibility that the active use of multimedia may contribute towards improved understanding of concepts [Bar-On, N. & Ben-Sasson, Z. 1997].

Learning to use the multimedia tool proceeds gradually. The teacher points out the possibility to use media, and guides students in their use, at various periods during class hours. Instruction in the use of multimedia is carried out in one of two modes:

a. The teacher identifies situations where varied expression, or creative activity may contribute to the acquisition of a new concept, to broadening insight, or to the general grasp of some phenomenon. Accordingly, the teacher exposes the students to the possibility of using graphics, colour, sound, motion etc. in relevant situations. b. The teacher announces that a specific tool will be introduced at a certain time, and anyone who wishes to learn how to use it, may join in. The first mode is employed mostly when the students are novices in the environment. Later on, they learn to identify their own needs in terms of use of the media, and ask to be instructed, or learn by themselves, the required functions.

It is important to state that the process is gradual for novices in the environment. Our 13-15 year old students gain mastery of the multimedia tool very quickly; by the time they start work on a full scale presentation, the program serves them as a real tool for self expression and creative activity.

Stages in the Progress of the Learner

Learning of a specific subject is divided into two stages. In the first stage, the teacher introduces the main subject to the students in a manner designed to stimulate curiosity and create a high degree of interest, either in the subject as a whole, or in some issues related to the main subject. We termed this stage "the exposition stage". The objective of this stage is to assist the learners in forming a general picture of the subject, to hint at the main themes it features, to expose possible points of interest for further research. At the end of this stage, each learner is expected to have formed her/his leading idea, either in the form of a question, a hypothesis, or a statement, which will serve as a central theme for her/his multimedia presentation.

The second stage is the independent study and construction stage. Each student is guided by her/his leading theme .Her/his learning activities are motivated by the need to construct a tangible product. There is no other incentive for learning. There are no exams. The use of multimedia plays a central role at this stage. As the student gathers the relevant information and develops her/his own conception of the leading theme, she/he also plans the structure of the multimedia presentation. Learners have complete freedom as to the design of their multimedia presentations. They are encouraged explicitly to make use of any medium, or any integration of media that would best express whatever they wish to express, be it interesting findings, personal point of view, the development of their own understanding of their theme, or anything they regard as relevant to their theme.

It is at this stage that the learners have opportunities for going through an interplay between internal and external learning processes. On one hand, they are involved in learning through independent research; on the other hand, they try to organize, adapt and design their knowledge and insights in order to integrate them in their product. The teacher may offer them points for consideration, but they also have a wide scope for creative activity. Their treatment of any and every issue connected to their work is always multi-faceted, bringing into account simultaneously questions of content, relevance, planning, design and presentation in multimedia.

While learners are engaged in their independent study, the teacher offers assistance and guidance in answer to their needs. At an early stage the teacher introduces the issue of evaluation. Students address themselves to questions such as what is the role of evaluation, how it may benefit them, and who should be evaluating whom. In "Media +", students participate as equals in determining the parameters for evaluation of their work. Parameters that may be considered include skills, knowledge, all the stages of planning and construction, and various aspects of the final product.

During a learning period each team can present its "work in progress". This may be done in several different ways. When advising who are about to present their work, the teacher stresses the fact that "work in progress" is to be understood literally, that is, it is unfinished and should not be expected to be complete in any sense. When presenting their half-way work, students may ask for any kind of feedback they wish to obtain from their peers. They may present whatever aspect they choose of their work, explain their leading theme and why they chose it, describe difficulties, ask for advice in some function of the program, tell why they chose specific visuals or vocals, and in general share with their peers whatever they wish to share. Teachers are advised to allocate 20 minutes for "work in progress" reports at the beginning of each class period.

Bumps on the Road

Some major difficulties should be pointed out. First, teachers have a hard time relinquishing their accustomed control over all activities in the class. They are expected to step off center stage and offer their assistance to the students in answer to their various needs. At the same time, they have to monitor the differential advancement of the teams, and intervene were and when they may be of most help. "Media +" head team helps teachers through courses, team support meetings and refreshment day-courses.

The second major difficulty is the intervention in the daily routine of school hours. "Media +" puts a heavy load on school hours and demands the co-operation of headmasters and many others from the school staff apart from teachers of the experimental classes. The load is heavy in more than one respect; "Media +" is certainly more time consuming than other learning methods. Teachers have to meet with teams - that is, pairs - of students several times during the leaning period. They have to learn efficient time-management among other things. "Media +" may be considered expensive because of the need to buy multimedia software, and pay for instruction for the teachers. However, the bulk of expenditure at the outset of the project in schools was met by the Israeli government, following a policy intended to upgrade learning and teaching levels in middle schools in Israel. In 1997, schools that join the project are usually equipped with the required hardware, and do not hesitate about purchasing the software. They may have a problem with financing staff instructors. Experience shows, however that if a school decides to join "Media +" on the basis of its educational credo, the management is not deterred by funding difficulties.

Implementation of "Media +" in a Science Class

"Media +" has been implemented for the last three years in some 30 classes in middle schools in Israel in experimental form. It is applied to the study of various subjects ranging from literature and history to science.

A preliminary evaluation of the environment was conducted in four 8th grade classes [Bar-On, N. Kampinsky, H. Ben-Sasson, Z. & Malka, H. 1996.]. We describe here the process and results from a science class.

The main subject was "heat and temperature". The focus of interest at the exposition stage was an experiment demonstrating phase changes of water through thawing and boiling. The experiment served as a source for questions raised by the students. Gradually, while discussing points of interest and clearing some unfamiliar terms, each learner discovers her or his personal interest in an issue related to the main subject. After the exposition stage, students chose themes according to personal interest and ability.

Some of the themes were: "How does a thermos flask function?", "What is the fate of the heat of a bonfire?", "How can a snow igloo retain warmth?", "Can the boiling point of water be changed?" "Why does a nuclear reactor produce heat?" The wide variety of themes reflects the variety of interests, and also, the differential ability of students to elaborate their own themes. Students were encouraged to look for materials in a wide variety of sources, and to include visuals, vocals and motion, as well as textual materials in their multimedia presentations. All learning of heat energy concepts was integrated in the research and planning of the presentations.

Research Results

Comparing several facets of learning between a "Media +" class (28 students) and a control class (26 students) at the same school, it was shown that:

1. In terms of general content knowledge, "Media +" students' achievements were roughly equal to or slightly better than those of the control class. In 7 items which tested content knowledge, the scores were [in % of correct answers, control group in parentheses] 76 (60), 17 (8), 70 (81), 50 (30), 70 (27), 25 (14) 81 (75).
2. "Media +" students showed an increased aptitude for asking questions. When confronted with an imaginary problem situation (you have to transfer heat energy from the sun via the moon to Earth, to prevent cooling down of earth), experimental class wrote 64 questions compared to 42 written by control class. Questions written by experimental class covered a greater variety of issues related to the original problem
3. "Media +" students were more ready to attempt an assignment of mapping concepts from a list. The list was composed by the tester, based on a list supplied by the teacher, of concepts that were learned. 26 "Media +" students undertook the assignment, compared to 13 of control; and they incorporated a larger number of concepts into their maps: 106 compared to 61 in the control class. In this assignment, students were permitted to add concepts that seemed important to them, and were not included in the list. 14 "Media +" students added new concepts (not included by the tester), compared to 5 control students who did the same.

Other items in the test show that "Media +" students have greater readiness to cope with unfamiliar or difficult subjects, and a more varied conception of what is a "central concept". In interviews, a great majority of the students expressed distinct preference for studying in "Media+". They said that this method of learning was much more interesting, mainly on two counts: the use of multimedia, and the fact that they worked on "their own thing". "Media +" was described by a majority of nearly 90% of the students as "great fun" "a great way to learn" etc.

A repeat of the test 3 months later shows that "media +" students retained more of the content learned compared to the control class. Results in the form of percent of correct answers to content questions show no decrease in number of correct answers of "Media +" students, compared to an average 30% decrease in correct answers of control students.

Results from 3 other schools confirm the general picture. "Media +" students may achieve slightly greater, or equal content knowledge compared to control groups. It is evident however, that they utilize a greater variety of skills, gain confidence in their abilities and learn to assume responsibility for their learning.

Conclusion

We conclude that "Media +" has achieved the following:

1. Students have improved their ability for independent study: they learned to ask questions, use various sources of knowledge, plan, design and process newly acquired knowledge to make it their own.
2. The multimedia presentation offers a wide scope for self expression and encourages use of the computer as a pedagogic tool. It promotes creative activity and construction as an integral facet of learning.
3. Learning through construction is a motivating experience and seems to be conducive to in-depth understanding, and longer-lasting memory of concepts learned.
4. The open, friendly and stimulating environment tends to make the experience of learning a pleasant one, and may enhance constructive processes of learning.

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[1] The IDEA Center, (formerly the Israeli Logo Center) headed by Dr. Nira Krumholtz, has been involved in the past eight years in research, development and implementation of innovative learning environments in the field of technology and science teaching and learning. Besides "Media +", the center has developed learning environments incorporating Logo, LEGO-Logo and LEGO-logic. The learning environments developed at the IDEA Center are open environments, applicable to a wide range of contents and disciplines, and compatible with a variety of learning and teaching modes.

NetworkTA: The CyberProf Conferencing System Exploiting Complex Systems in a Collaborative Learning Environment

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Abstract: The CyberProf conferencing system, known as the NetworkTA, is a Web-based system for interacting and collaborating in an educational environment. The NetworkTA is integrated into a very sophisticated software package known as CyberProf, an intelligent human-computer interface for grading, creating, and presenting educational course materials on the World Wide Web. The design of NetworkTA, like that of CyberProf, exploits complex systems theory in particular methodologies for control chaos and attempts to enhance the student learning process through nonlinear resonance. We explore the use of these methodologies in the context of a conferencing system.

Introduction

The World Wide Web is an excellent medium for communication, with widespread accessibility and the ability to deliver text, sound, and images. CyberProf, an intelligent, interactive human-computer interface created at the Center for Complex Systems Research in association with the Beckman Institute located on the University of Illinois at Urbana-Champaign campus, was developed as a teaching tool which intelligently presents and grades educational course materials through the World Wide Web. Development of the NetworkTA is based on CyberProf which already successfully applied complex systems theory [Cowen et al., 1994] [Forest, 1991] [Lam and Naroditsky, 1992] [Hubler and Assad, 1995] [Bloom and Hubler, 1996] to development of homework and lecture notes in online instruction. Examples will be described to illustrate how the NetworkTA (the conferencing system component of Cyberprof) creates a collaborative environment which can exploit psychological resonance among students.

CyberProf and the NetworkTA can be obtained free of charge. Interested people are welcome to visit CyberProf on the World Wide Web at http://cyber.ccsr.uiuc.edu/cyberprof/, and can engage in a demonstration version of the NetworkTA at http://cyber.ccsr.uiuc.edu/dpt-bin/1997/0.6/cyberprof.cgi?CPscriptname=nta06. In addition, several courses at the University of Illinois use CyberProf and the NetworkTA and offer guest login to the NetworkTA.

The NetworkTA for Electronic Conferencing

Electronic conferencing is beginning to impact the way people learn and interact. Email and electronic conferencing allowed students to conduct group projects in educational psychology courses at the State University of New York College at Cortland. Participation in the electronic conferencing was silently monitored and evaluated by the instructor and questions were answered when necessary [Anderson, 1995]. Online conferencing was used to evaluate writing skills for elementary and high school students and was found to be an effective instructional tool that also transformed the classroom from a competitive environment to a cooperative one [Stuhlmann and Hochella, 1995]. Business students at Northeastern University reported improved quality of instruction and better access to instructors as a result of email and computer conferencing [Zack, 1995]. Computer conferencing was used to teach writing skills [Leppanen and Kalaja, 1995].

In addition, electronic conferencing through a widely available medium removes the space and time constraints allowing more flexibility for students and instructors while introducing students to using technology. The role and impact of computer communication in education are detailed in various literature [Manrique, 1994] [Berge, 1995] [Harrington and Hathaway, 1994].

The NetworkTA is a Web-based conferencing system which provides a medium for interaction and collaboration between students and the course director. The NetworkTA capitalizes on the Web's ability to allow interaction without the need for physical and temporal proximity. Everyone can participate in any convenient location such as a campus computer lab, a dorm room, or a home many miles away from campus. Widespread accessibility to the NetworkTA can promote communication and collaboration on homework, projects, and other assignments. Also, the NetworkTA is easy to use. The NetworkTA accomplished this by exploiting the Web browser paradigm. The layout of objects, such as icons and descriptive text, is arranged to be visually easy to interpret. Menus, hypertext links, buttons and text boxes allow user interaction with the software. The NetworkTA's accessibility and an easy-to-use interface facilitate and enhance student interactions.

What distinguishes the NetworkTA system from other conferencing packages is its effective use of complex systems. Consider a harmonic oscillator. The system resonates when the forcing function matches the rhythm of the oscillator. It is conjectured that this concept can apply to a complicated system such as communication. Communication through the NetworkTA can produce strong interactions for students with other students. Students consult with online student tutors and fellow students to whom they can relate effectively, resulting in psychological resonance. This can be explained in terms from complex systems theory. The online student tutor (or classmate) mirrors the dynamics, behavior, and ideas of the student very closely. Next, the online tutor (or classmate) intentionally deviates slightly from the mirroring in order to impart information which guides the student in the correct direction. How the NetworkTA strives to accomplish this is described in examples of its use in courses at the University of Illinois.

The NetworkTA Conferencing System

Economics

At the University of Illinois, the NetworkTA serves as a chat forum for Professor Jane Leuthold's economics courses. Through online conferencing, this course director creates an environment where students can freely participate. Because participation in the NetworkTA is recorded and graded, many students contribute to the discussion. In addition, no bonus or penalty points are assigned for "good" or "bad" writing samples so that students are free to address the discussion topic, express their opinions, and develop writing skills, under less pressure. In the process, students help each other develop their own thoughts. The course director's enthusiasm for electronic conferencing through the NetworkTA, an alternative to conventional face-to-face exchanges, encourages students to contribute the online discussion.

The structure and organization of the NetworkTA conferencing system foster this development. Messages are threaded and grouped by initial topic thread as shown in [Fig. 1]. Messages are further grouped into discussion boards. Finally, discussion boards can be even more highly organized into layers of discussion boards, folders of discussion boards, and folders of folders, and so forth, similar to [Fig. 2]. In the example shown in [Fig. 1], the course director begins the discussion board by composing a new message which introduces the chat topic on which she has chosen for the students to debate.

> Our first chat topic deals with the issue of internet pricing on campus. Check out the UIUC policy for internet pricing described at http://www.uiuc.edu/ccso/announce/tscharge.html. See if you think the campus is using an effective pricing scheme for allocating this scarce resource. Would you suggest any changes? Post your opinion to the Chat in the form of a short paragraph. Feel free to comment on the opinions expressed by other students -- the purpose of the Chat is to provide a forum for economic discussion. Maybe we can come up with some suggestions to improve the internet pricing system on campus!

Shaun, the student with login name *smcarlso*, follows the discussion board by reading the course director's introductory thread through a mouse click on the hypertext link. Next, he starts a new thread detailing his opinion.

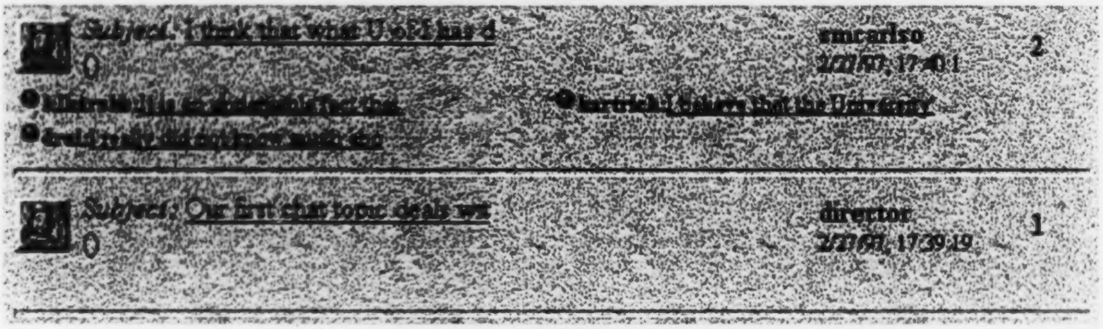
> I think that what U of I has done with the pricing is very fair. To start, every student with an account has the right to 20 free hours dial up access. For most students, that is more than enough time to get done

> whatever needs to be done through the network each week. Also, if they need more time, they can get it at a rate of only $.30 an hour. That is more than reasonable…

Students read Shaun's message and interject their own opinions by responding directly to Shaun's posted message in the same thread (shown in [Fig. 2]) or by initiating a new thread (not shown). Students freely respond to each other in these discussion boards because they share similar experiences and express their thoughts through their writing using the familiar forms of colloquial and formal language. Through, the NetworkTA, strong interactions among students who relate to each other extremely well can result in psychological resonance.

In the above examples, simple text and a single hypertext are used in the message. However, messages in the NetworkTA can also include text, sound, still images, video, and special HTML extensions specific to CyberProf, including LATEX-like commands for typesetting of mathematical expressions and special symbols. To simplify exploration of messages, only the top level message of each thread is emphasized and all threaded daughter messages are associated with the top level message. Information such as subject heading, topic line, author, and thread number uniquely identify the original message of the thread. The subject heading for each message introduces the content of the message which may lure the student into reading the message. Because several participants can simultaneously interact through the NetworkTA, the list and contents of the threads are dynamic as they are continually updated.

In addition, the NetworkTA allows students and instructors to know who is currently using the system, so that participants can engage in a more synchronous discussion which can be useful for group projects. In this way, students can use the NetworkTA for collaborative projects where a group can coordinate plans and share ideas.



Subject: I think that what U of I has d
0
smcarlso
2/27/97, 17:40:1
2

Subject: Our first chat topic deals wi
0
director
2/27/97, 17:39:19
1

Figure 1: The NetworkTA Message List page lists threaded messages in a discussion board.

Physics and Chemistry

Professors Alfred Hubler, Barbara Whitmarsh, and Susan Arena manage the CyberProf software package for several physics and chemistry courses at the University of Illinois. In these courses, CyberProf provides students with online lecture notes and homework problems. Students complete homework assignments online and receive instant feedback upon submission of their homework. CyberProf intelligently analyzes the students' answers, reports specifically what is wrong with their answer (if their answer is incorrect), and allows them to try again. Even so, students can have difficulties with homework assignments. Additionally, concepts presented in class may not be clear to the students.

For these courses, messages on the NetworkTA are posted and threaded in the same manner as described for the economics course. However, the fashion in which students, online tutors, and course directors use the NetworkTA can vastly differ. Here, the NetworkTA serves as a forum for participants to pose questions about the homework and concepts presented in class and to reply to other previous questions.

Participants have customized NetworkTA sessions. New messages posted since the participant's last session are indicated by a prominent "Updated" icon next to all the discussion boards containing new messages. This makes it easier for students, online students, and course directors to find the messages they need to read in order to be up-to-date. Online student tutors and course directors are further aided by a "New" icon next to all discussion boards having threads which require attention [Fig. 2].

To find specific content in the current list of threaded messages, participants can enter keywords to search for messages containing those keywords. For example, a student preparing for an upcoming exam needs help with kinetics. The student can perform a keyword search on the word *kinetics*. The NetworkTA will display all the

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threaded messages containing the keyword *kinetics*, and the student can read homework and lecture questions regarding kinetics.

The NetworkTA is used in conjunction with CyberProf to help students understand conceptual and practical difficulties presented in the lecture, online homework assignments, and the textbooks. Students who have successfully completed the course the previous semester are paid to teach and to respond to online questions presented by current students. The hours served by the online student tutors cover most of the day, seven days a week. Interaction through the NetworkTA can develop psychological resonance among students. Because the online student tutors are students themselves, students currently in the course are apt to ask questions and share statements more freely. Also, the online tutors relate more closely to students and communicate in less complicated terms so that students can understand.

Students have access to online tutors, graduate teaching assistants, and course directors during most of the day. A student can come in contact with other students online, some of whom they might not meet in the classroom. Course directors may monitor activity on the discussion board and can join in the discussion. This would not be the case in the classical educational environment where outside help is commonly obtained during fixed office hours and where interaction with classmates may be limited.

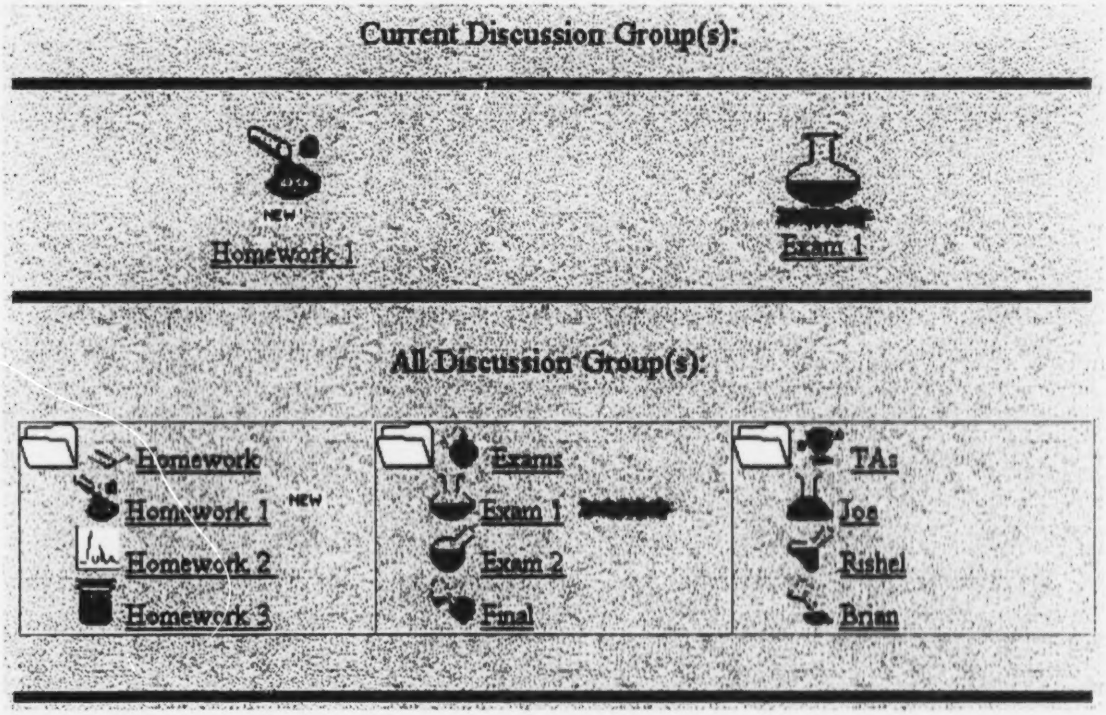

Figure 2: The NetworkTA Navigation page displays the currently active discussion boards prominently at the top of the page above the list of all discussion boards. Also, the organization of the discussion boards in the conference is represented in a tree structure consisting of folders and discussion board icons.

Biology

Professor Deanna Raineri, the director of biology's CyberProf website at the University of Illinois, uses CyberProf and the NetworkTA in the same manner as the course directors in physics and chemistry. Students complete homework assignments online using CyberProf and interact with other students and the course director through the NetworkTA. Customization of the NetworkTA by this course director illustrates the flexibility of the conferencing system. Customization allows course directors to create an environment which best fosters enthusiasm and effort for learning the course material, allowing natural resonance among conference participants to occur.

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Through customization, the instructor modifies the NetworkTA's interface to facilitate student usage and to improve student interactions.

The NetworkTA consists of several logically different components, all of which are easily customized from the password secured Director Options menu. The Navigation page displays the available discussion boards and the organization of the discussion boards. The Message List page lists all the threads in a discussion board. The Word Search window provides a simple menu to display messages containing selected keywords on the Message List page. The Log of Users page publicizes a registry of current NetworkTA participants. The Compose New Message page allows participants to initiate a new thread in a discussion board. The Read/Reply Message page displays the contents of a posted message and permits the participant to respond to the posted message. The appearance and function of all NetworkTA components are determined by the course director. Many pages include director defined page headers and footers which can serve a variety of functions ranging from general announcements to special instructions. Often, these include a banner, links back to the course homepage, and links to other related Web sites.

The NetworkTA offers a simple installation procedure for the director to setup the initial framework. From the beginning, it is essential that the initial setup does not intimidate or discourage the course director. A course director who is enthusiastic about online conferencing will encourage teaching assistants and students, and can influence the degree to which teaching assistants and students get involved and interact. The initial installation includes creating the structure and determining the content of the discussion boards. After the initial setup, a more in depth installation can be made to further customize the NetworkTA.

To simplify use of the NetworkTA by discussion participants, the director defines a subset of all discussion boards to be the currently active discussion board. This subset is physically separated from the list of all discussion boards to allow easy selection. This can be seen in [Fig. 2]. In this way, participants can easily find the discussion boards that they should probably be using for that day. This is done by assigning each discussion board a starting active date and an ending active date. The NetworkTA compares this information to the current date and assigns the active discussion boards to be the current discussion boards.

Because participants are constantly contributing to the discussion boards, the list of messages within a discussion board is always growing. While waiting for a response, the participant will not be left staring at an empty screen until a new message appears on the page. The course director, upon installation of the NetworkTA, can customize an audio cue to sound the arrival of a new message.

For the most part, messages in the discussion boards contribute to the topics chosen by the director but there are instances when they may not. A participant may post an offending remark in a discussion board. A student taking an early final examination might post some of the questions to the final on the NetworkTA before the rest of the class has taken the exam. In such situations, the course director can selectively filter inappropriate messages so that participants will not read them.

Results

Examples of the NetworkTA used in courses at the University of Illinois at Urbana-Champaign provide insight into the different roles of the NetworkTA and how it interfaces students with other students, online tutors, and course instructors. Most of the features in the NetworkTA have been created as a result of the goals of individual course directors. Course directors have found that the flexibility in customizing the appearance and function of their version of the NetworkTA has been invaluable. The NetworkTA has provided students with better access to instructors and other students.

Currently, several institutions are using CyberProf and the NetworkTA including the Bradley University, Wayne State University, George Mason University, Universidad Nationale Autonomade Mexico, Purdue University, University of Illinois at Urbana-Champaign, Parkland College, Urbana High School, and Homehi. In addition, other courses at the University of Illinois also use CyberProf and the NetworkTA. Course instructors and online tutors for some courses use the NetworkTA to respond to student questions related to homework, laboratory exercises, exams, and course administration. In other courses, students engage in online discussions and exchange ideas about course related topics, mediated by the course director. The NetworkTA becomes a platform for students to develop arguments on "paper" and to receive feedback from the instructor and other students. As a whole, the reaction to the NetworkTA from course instructors has been highly favorable.

Future Work

The NetworkTA is continuously updated with new features as the growing needs become more apparent. Feedback from student evaluation committees and course instructors will continue to play an important role in the development of the NetworkTA. While the NetworkTA presently has much to offer as a medium for collaboration and communication, many new features are still in the works. The uploading of sound, image, and video information from the client machine to the CyberProf server will add interactive multimedia and enhance interaction among NetworkTA participants. Communication through the NetworkTA will be improved using WebDraw-WebPlot, CyberProf's online whiteboard. For courses which also use CyberProf to assign homework, requests have been made to allow online student tutors to view the homework solution to the exact problem assigned to a particular student through the NetworkTA.

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DUSIE: Augmenting a Static Web with User Defined Content and Link Structure

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Abstract: At present, facilities allowing users to add structure and content to existing Web documents are scarce. From a usability view, bookmarks and cookies are useful tools allowing users to define some measure of conceptual structure to a set of documents. In the educational context, creating an evolving, user-created concept structure is an important component to support learning as concepts are actively organized and re-organized. The Dynamic User Searchable Index Engine (DUSIE) provides facilities for users to define supplementary links within and across Web documents using existing content to create a link metastructure and to add new content through annotations. In the student-centered electronic learning environment in which the system is used, DUSIE provides a means to augment existing content material with a student-created view of concepts.

Introduction

The dramatic growth and widespread acceptance of the World Wide Web provides open accessibility for an unprecedented amount of information. The promise of Web-based hypertext documents lies in the ability to produce complex, richly connected and cross-referenced bodies of information. However, the documents can become a system of tangled webs confusing both author and reader. This is primarily because the most widely used tools for accessing Web documents provide neither a sense of the overall relations of documents nor facilities for the user to impose a structure unique to his or her view. In the Web hypertext there are no simple organizational schemes, such as page numbering, that can serve as ubiquitous and commonly understood paradigms of navigation and location. In particular, the static nature of HTML documents and relatively limited indexing and navigation mechanisms of the most widely used browsers do not realize the potential for general hypertext systems. Facilities which support users in creating alternatives to the static link structure of Web documents are not in general use.

Augmenting Web Structure for Learning

The restrictions of most Web systems are particularly limiting in educational environments. Nuthall and Alton-Lee [Nuthall and Alton-Lee, 1993] suggest that as students are involved in activities about a topic, they store a representation of the information about the topic in their working memories. These representations become connected and integrated with other related information about the topic in semantic memory - a schema. Representations which do not get connected to the existing infrastructure are lost. If, however, enough representations are integrated and connected, the ideas become established in long term memory. Sometimes, however, information is misinterpreted and reorganization is required.

A similar thread underlies the learner centered principles set forth by the American Psychological Association Task force on Psychology in Education [Presidential Task-force, 1993]. Learners seek to make sense out of what they are given, no matter what the quality or quantity. At times this leads to misconceptions, but these must not be discounted in the effort to achieve deeper understanding as learners link new knowledge with old knowledge. Furthermore, metacognitive abilities should be fostered in the learning environment.

Multimedia presentation techniques, including web-based computer aided instruction, have been applied successfully to support or enhance learning environments. Success in these environments is often attributed to the engagement of the student in an active learning process. Student's efforts to understand are placed at the center of the educational enterprise and emphasis is on the student's construction of knowledge. However, Weingrad et al. [Weingrad et al., 1993] point out that all too often the use of multimedia in the learning environment is an interactive activity for the author through the explicit definition of concepts and links, but remains a rather passive activity for the student user. Still, this passive activity can have a significant impact on student understanding based on the supposition that an implicit ordering and reordering of the information occurs.

Facilities supporting active engagement by hypertext readers are among the functions characteristic of second-generation hypertext systems, facilities not yet in widespread use in the Web. In describing issues to be addressed by hypertext systems Halasz [Halasz, 1988] identifies both dynamic, or virtual, structures and extensibility, or tailorability, as important components. Users should be able to move through the system according to their needs without spatial or conceptual disorientation. There should be facilities for annotation and placemant of bookmarks or creation of indices. Facilities providing these functions would allow users to more effectively accomplish tasks and would support the learner in overcoming many of the limitations of hypertext as a medium for learning.

Current navigation and bookmark facilities for the Web

Current facilities supporting the organization and retrieval of information contained in web documents are in practice extremely limited. Bookmarks are perhaps the primary tool in widespread use. When adding a bookmark, the address of the document is initially added to the bottom of a list, and perhaps later manually placed in a hierarchy. The bookmark then points to a document, rather than directly to the area of the document containing the point of interest. Retrieval of the associated information is as simple or difficult as viewing the list or hierarchy, selecting the bookmark, and then going to the document to continue the search for the item of interest. The context of the bookmark is removed from the original intention. Clearly, bookmarks are not enough.

There are many ways to navigate through web-based documents using current browsers, including hyperlinks, menus, toolbar buttons, location boxes, and directory entries. However, most facilities require users to have knowledge about the location of the information, rather than supplying facilities for content-based access. Sites on the Internet can be saved and revisited, but the focus is the page or site, rather than the content or even exact location. Therefore, users often must continue the search for the desired information even after following markers they have set.

This sort of location-based navigation, browsing, and information retrieval is effective for small hypertext systems, but for large hypertext database systems like the Web, information retrieval through navigation and queries becomes crucial. This is particularly true when the user is in an educational setting and searching to find and organize new information. Content search techniques can be extended to web documents [Beeri & Kornatzky 1990]. All nodes and links can be treated independently and examined for a match to a query. The use of structural queries has also been suggested where specifying terms are used to retrieve edges, paths and cycles. The set of elements retrieved is collapsed into a hypertext network and users can incrementally compose queries.

Another type of content-based structuring of hypertext document content was suggested by Bruza [Bruza, 1990]. The approach uses a two-level architecture for hypertext documents where the top level "hyperindex" contains index information and the bottom level "hyperbase" contains content nodes and links. The hyperindex consists of a set of indices which are themselves linked together. When an index term describing the required information is found, the objects from the underlying hyperbase are retrieved for examination.

A Hypertext Environment for Learning: PDP

The Programing Design and Programming (PDP) project [Fowler & Fowler, 1993] focuses on developing and implementing a student-centered virtual classroom for introductory computer science courses. PDP incorporates courseware and tools that create a student-centered learning environment to develop a life-long learner skilled in information access and utilization. The virtual classroom centers on an integrated set of software tools: 1) hypermedia notebook (PDP "text book") with class notes, executable examples, assignments, etc. 2) a pedagogic computer aided software engineering (CASE) tool, 3) an algorithm animator, 4) a programming language facility integrating editor, compiler and debugger, and 5) news group and e-mail facilities to support electronic collaboration and mentoring. The structuring of student activities through laboratories and electronic communication is designed to support the student by creating small scale communities of learners in which to work [Fowler & Fowler, 1996]. Students have an opportunity to express themselves via multiple paths - program design, programming, and writing to enhance their problem solving skills.

The extensive use of electronic tools is natural in the discipline and has allowed us to develop this rich and interactive suite of tools to enhance both the learning and the teaching environment. The PDP hypertext, CASE tool, and algorithm animator allow us to present ideas visually and interactively in an environment that facilitates experimentation. Students use the hypertext as a scaffolding to organize concepts and explore the knowledge base, while completing practical work using tools that are relevant in the real world. The supposition is that the user gains understanding through the exploration and implicit ordering and reordering of the information by actively interacting with the hypermedia, and through the transfer and transformation of information from one tool to another.

A Tool for Ordering Content and Creating Structure

Though the tool intensive and highly integrated PDP virtual classroom provides a rich assortment of resources to support information retrieval and understanding, the original tool set did not include a tool which facilitated the capture and organization of meta-knowledge about the resources, particularly the hypertext documents. Supporting the idea that it is the user's perception of the concept structure that is important in the learning environment and the ability for the user to organize their concepts as they perceive them, we have developed a set of tools with which the user is able to construct a personal repository of concepts and concept relations to complement the author centered document structure. As an extension of the virtual classroom, the tools reinforce learning through the active construction of an associative network of terms and annotations. Students explicitly define their understanding of the concepts by creating an index into the hypertext document. They impose their ordering on the concepts and modify their ordering as their perceptions of the concepts change. The tools provide facilities to move through hypertext documents, construct a network of associated concepts, annotate the document, and modify the user-created index as appropriate.

This user-created dynamic open indexing system, which can connect to other information resources and allows individual annotation, provides the sort of functionality suggested above for augmenting Web structure. The goal of the user-created index is to reduce cognitive overhead by allowing users to define an index using their own terms, based on their understanding. Each index term contains semantic information relevant to the user. The indexing system keeps track of nodes and links to conceptual materials, thus providing a navigational tool through conceptual space. With its additional ability to cross-reference, the index is often more relevant to the user than an index created by the author. The tools are introduced in conjunction with the virtual classroom and the associated hypertext document. Yet, they are not limited to use in that environment. The user can integrate materials from any other web based hypertext document, as well.

DUSIE Searchable Indices

In the simplest terms, the Dynamic User created Searchable Index Engine (DUSIE) provides users facilities to construct an index for Web documents. Users define a list of index terms, make annotations to the terms, and link related concepts. In the context of the educational setting in which DUSIE was developed, a primary function of the indexing process is to provide a set of terms for each document that reflects the user's conceptual domain and can be used efficiently and effectively to retrieve information from the document. More generally, the system's functionality supplies mechanisms to create 1) new nodes through the annotation facility, 2) links to points in existing Web documents for the new nodes, and 3) alternative links for existing Web nodes through the addition of terms linked to points in existing documents.

Creating the Index

While Web documents use a static and explicit model of hypertext, i.e., nodes, links, and link markers are fully enumerated during creation, DUSIE allows the user to create a virtual structure or model of hypertext through a user defined indexing scheme. The virtual structure, or user defined index, has two levels: the index term level with annotation capabilities and the hypertext base level [see Fig. 1].

The index is made up of a set of index entries. Each index entry consists of a term descriptor or keyword supplied by the user, a locator (like an HTML anchor), an annotation area, and a set of related term descrip-

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tors. The term descriptors are as general or as specific as desired by the user. Any particular index term provides a focus for the set of related concept descriptors and so a broadening or refinement of the concept represented by the focus index term. The focus term and the set of related concepts then creates a structure that can be used to support query by navigation. In turn, these indices provide immediate access to required information without navigating through the document space.

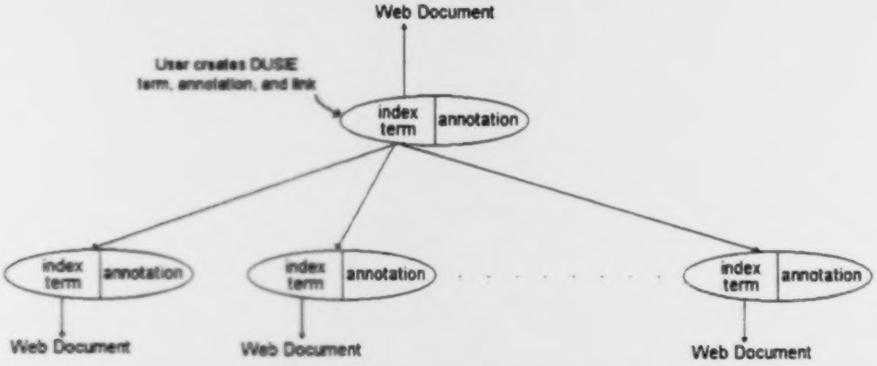


Figure 1. User-created DUSIE links and nodes supply annotations and connections to Web documents. DUSIE nodes can have multiple targets through additional terms linked to a node.

When using DUSIE, an index term is first defined by the user, and a new index term node is created and inserted into the index level. A link is made from the new node to the location in the hypertext document specified by the user. The node is also linked to an annotation block, providing space for the user to make an annotation about the term. After a new index term is defined, the user can define relationships between the index term and other index entries. If a relationship is defined, a link is created from the focus index term node to the related entry node. This creates a set of index entry nodes linked together. The assumption is that the links are created because the user perceives a relationship between the index terms represented by the nodes. As the user's perception of the concept materials change, the user can modify the index term network by adding or deleting links between nodes. These user defined relationships among entries serve somewhat as a user defined thesaurus of index terms, even though the terms are not distinguished as synonymous or subordinate, rather just as related concepts. This facility allows the set of index entry nodes to be used later in navigation through the hypertext, as well as for more explicit retrieval of information.

The user can make an annotation for each term entry in the index. The annotation might contain explanatory notes, materials to extend the original document content, or even a part of the actual document text. The annotation can be modified at any time as users' knowledge or perceptions change.

Though the indexing scheme incorporates a two level model, the implementation of DUSIE uses a three level architecture: information source (database), index application which creates the user defined conceptual structure, and user-interface client (Java virtual machine). This architecture was chosen to simplify modification of system components, particularly the user interface. The database stores the user created index structures on a file server. The index application retrieves information from the database and creates the user defined structure, while Java and Javascript are used to support the user interface.

From the user's perspective, the Java-based application looks and feels as though it is a part of the PDP hypertext document. Upon invoking the index option from the PDP hypertext document, the applet is downloaded and the application executed. The user's information is retrieved, the index structure is created and finally the user's index and the commands to modify, save, and exit the indexing engine are displayed.

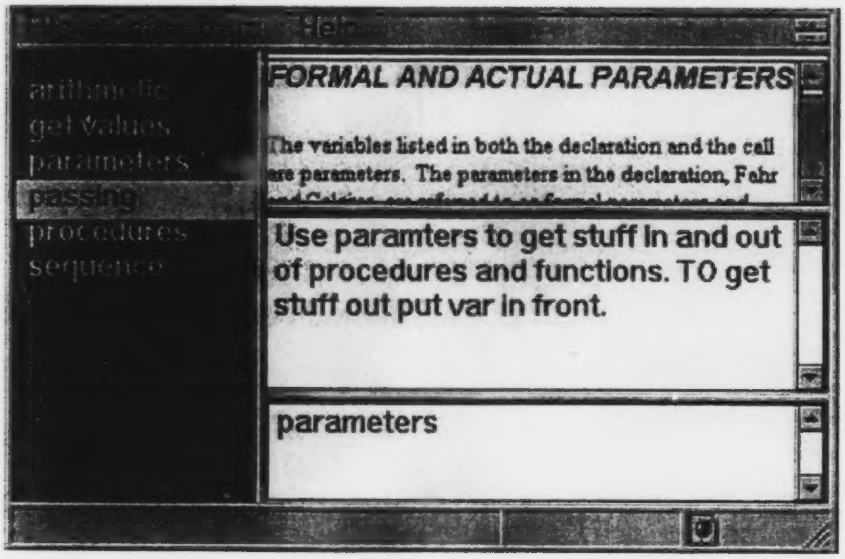
A Query Tool for Information Retrieval

DUSIE provides content retrieval in a manner similar to Bruza's two-level architecture for hypertext documents through a top level index information and a bottom level containing content nodes and links. In the DUSIE implementation the hyperindex is a set of indices linked together. When an index term describing the required information is found, the objects from the underlying hypertext document base are retrieved for examination.

Retrieving information in this manner is retrieval through navigation. After selecting an index term, the information associated with the hypertext base link is displayed in the browser. The annotation can also be displayed in the browser. Information may also be retrieved using the related concepts entries, facilitating the retrieval of semantically related materials. The user can move directly to the desired information as well as access related information without having to remember locations, links or other structural details. As a reflection of the users conceptual domain, the index terms might be considered metanodes which are linked to other metanodes via terms in the related concepts term set. In this way the index system expresses local relations among clusters of nodes.

Using the System

One way to get a feel for the system is to walk through a sample session using the system. Typically, the user is working in the distributed environment, and has a number of windows open on the screen. One of the windows contains a web browser opened on the web based courseware. From the main table of contents of the course's PDP hypertext, the user invokes the index by submitting their account name and password. A Java applet is downloaded and executes the index application. Upon verification, the user's database is retrieved from the file server.



FORMAL AND ACTUAL PARAMETERS

The variables listed in both the declaration and the call are parameters. The parameters in the declaration, Fahr

Use paramters to get stuff In and out of procedures and functions. TO get stuff out put var In front.

parameters

Figure 2. PDP user index window displaying index terms, hypertext reference, annotation, and related terms for a user defined index.

The user defined index structure is displayed in the PDP - User Index window [see Fig. 2]. The display window contains five areas: the menu, the index term list, linked hypertext, annotation, and related concepts list. The menu provides commands to add, annotate, add related concepts, delete, save and close the index. A list of the user's previously created index terms are displayed in the index term window. The user selects a term from the index list to view the indexed area in the courseware. The area of the hypermedia document referenced by the index term is displayed in the text frame of the window. Any associated annotations are displayed in the annotation area of the window, and terms designated as related terms are displayed in the related terms area of the window. The commands available from the edit menu allow the user to enter new terms into the index, modify their annotations, and link related terms. By choosing from the related concept list for an index term, the user can use the index as a navigational tool through hypertext documents.

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Prototype Graphical Interface

With increasing use of visualization techniques in the presentation, retrieval and navigation in information spaces, a prototype graphical interface is under construction. The principle visualization is a network display based on the user constructed set of index terms and related concepts sets. Index terms are viewed as nodes in a network displayed in three dimensions using tools developed for general display of Web document relations [Fowler et al., 1996]. User defined relationships between nodes appear as edges. The nodes and edges in the visualization provide information about the user's perception of the document information and their imposed ordering. The nodes in the network represent entries in the index set while the edges represent links to related index terms. Since perceptions change, a critical component of the network visualization is the ability to modify the structure of the relationships by adding to, deleting from, and modifying the existing edges. The visual environment also supports exploration and retrieval of information. Given that a node represents an index entry denoting a particular concept, the material can be retrieved or other related concepts can be retrieved by following links in the term network display.

Conclusions and Future Directions

DUSIE provides tools allowing the user to create, modify, and save an annotatable index for web documents. This functionality allows the user to create user-centered semantic networks of document concepts to complement the author-centered structure. In essence, users are able to construct their own extensible hypertext which constantly evolves as their understanding of the subject matter and need for information evolves. The students' index structures maintained by the system provides a source of information about the students' perception of relations among concepts. The ways in which our perception of the structure of the course content differs from that of students may suggest ways to modify content, documents, and pedagogy.

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Intelligent Hypermedia Learning System on the Distributed Environment

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Abstract : This paper suggests using a hypermedia learning system which has the ability to extract intelligent instruction on the world wide web. The proposed system is designed for supporting individual instruction on the web. The system is composed of expert module, student module, instructional strategy module and network interface module. To implement this system on the world wide web, we use CORBA-based CGI application for user interaction. To diagnose students' responses and generate evaluations, we use several linguistic variables.
The advantages of using this system are intelligence and distribution of resources. Intelligence of the system is dynamic generation of problems and the ability to provide a dynamic instruction strategy. In addition to showing instructional unit network and students' learning paths, we can overcome disorientation problem that have frequently occurred on the web. We use CORBA to overcome the disadvantage of WWW, passive protocol, HTTP.

1. Introduction

The WWW(World Wide Web) has been spread world-wide as a standard of distributing multimedia/hypermedia information. There are many applications based on the WWW, such as video on demand, distance learning, home shopping, and so on[Kappe 91]. The advantage of using distance learning on the WWW is apparent. We can provide instructional information using a hypertext form, the same as students' cognitive structure. Many studies in progress have interactive instruction made achievement[Dwyer et al. 95, Ibrahim & Franklin 95, Carver & Gregory 95]. Distance learning is available by exchanging instructional information via network among students and instructors at a distance. But WWW users ask for many extensions : integrating new kinds of web resources, extending web browsers, changing stateless web protocol. These problems can be overcome with a uniform model of resource interfaces, and transportable front-ends, that could be generically integrated in WWW. A uniform paradigm to encapsulate and structure web components can be achieved thanks to the OMG(Object Management Group)'s CORBA(Common Object Request Broker Architecture)[OMG 95].
Despite the WWW is able to access distributed information and services on Internet, it does not present individualized information to students[Jonassen & Mandl 90]. In addition, unlike existing stand-alone ITS(Intelligent Tutoring System)[Yoon & Wang 94], students must have the ability to study freely and search related information easily. Therefore the system must overcome potential disorientation problems[Kappe 91] that could burden accessibility.
In this paper, we suggest an intelligent hypermedia learning system that can make intelligent instruction and individual instruction on the CORBA/WWW. Our system can support concurrent learning and dynamic lesson planning for each student by using linguistic variables[Yoon & Wang 94]. In addition, our system provides instructional units in which students' response are diagnosed, and compared, thereby allowing dynamic instructional strategies to develop in step with the students' progress.

2. World Wide Web for ITS

In this chapter, we survey the merits and the defects of the WWW as an environment for ITS, while examining ITS' present approach on the WWW.

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There are several merits to using the WWW for the environment of ITS. It is possible to study in a human way when the ITS is implemented on the hypermedia based on the WWW. Also, it is possible for many students to share the same tutoring material on the WWW. The growth of web sites has also given the student the opportunity to utilize information from all over the world[Lee et al. 97].

However, several problems do exist when using the WWW as an instructional device. Due to the limitless nature and sheer size of the WWW, it is often difficult to verify or diagnose a given student. The disorientation resulting from the great vastness of the WWW must also be overcome. In addition, students have difficulty obtaining the overall courseware structure of the ITS on the WWW.

CALAT is the present ITS on the WWW[Nakabayashi et al. 95]. This ITS is composed of the WWW and an individual tutoring system. In CALAT, the developers intended to solve the student verification, diagnosis and disorientation problem on the WWW. Using CALAT, an expert module decides the instruction path in order to prevent the disorientation. This decreases the effect which can occur while using the vast WWW for tutorial material. However, CALAT developers utilized their previous stand-alone ITS which suffers from heavy user loads as well as recognition loads due to the vastness of the WWW.

In this paper, we describe the design and implementation of a hypermedia learning system with intelligent factors. This suggested system can support concurrent learning, dynamic lesson planning and individual instruction for each student. Our system can provide the various path to the students so as to utilize the educational merits of the WWW. When a student becomes disoriented, our system provides advice to the student. We designed our system as a multiprocessing system so the loads of our system can be reduced when there are many students connected to our system. Finally, we provide the overall courseware structure to the students so as to reduce the recognition loads of students.

3. Design of the System

[Fig. 1] represents the configuration of the intelligent hypermedia learning system. This configuration, similar to a stand-alone ITS, is composed of the expert module, student module, and the instructional strategy module. In addition, our system includes the HTTP demon and CORBA-based CGI(Common Gateway Interface) application for the interaction between students and the student module, and IIOP to HTTP Gateway module for transmitting HTML document to student.

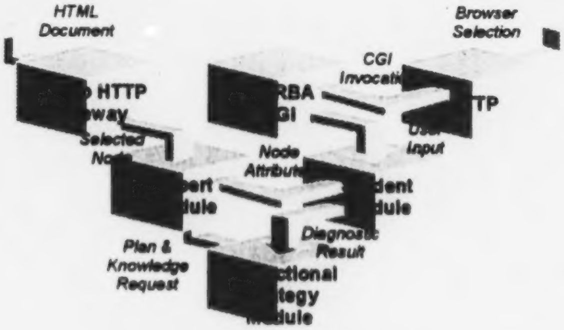

Figure 1: Configuration of system

In our system, many students can learn within the provided courseware. Student module diagnoses, infers learning state of present student according to the student database which store the information of each student. By using this diagnosed result the student instructional strategy module decides the next lesson, and transmits the courseware in HTML form. Thus the individual learning can be provided.

The courseware which exists in the WWW is transmitted to the student through IIOP to HTTP Gateway, then sent to HTTP so that the students can learn by using general WWW browser. Student module uses CGI application in order to receive the data for learning because the standard HTTP cannot receive the input of the user. All the input of the student is collected through the CGI application. And this information would be used to decide the instructional strategy.

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3.1 Interface modules

Our system use the CORBA ORB and the CORBA CGI applications. Therefore, we need protocols, HTTP and IIOP. When a student selects some link, that selection send to HTTP demon using HTTP. Then HTTP demon invokes CORBA CGI application. The codes of CGI application are distributed over servers using CORBA object implementation.

During some object implementations are executed, the student module diagnoses student's selections. The student module sends diagnosed result to the instructional strategy module and current state of that student to the expert module. Then the instructional strategy module plans that student's next lesson. And the expert module selects appropriate materials and creates HTML document from them. This document the expert module creates, is not in web server machine. Because of that, we need some other method to send materials in HTML form to student's web browser.

The CORBA ORB uses IIOP, that we cannot use to send HTML documents to student directly. Then we implement the IIOP to HTTP gateway to distribute all the material and student information. The IIOP to HTTP gateway module converts protocol from IIOP to HTTP.

3.2 Expert module

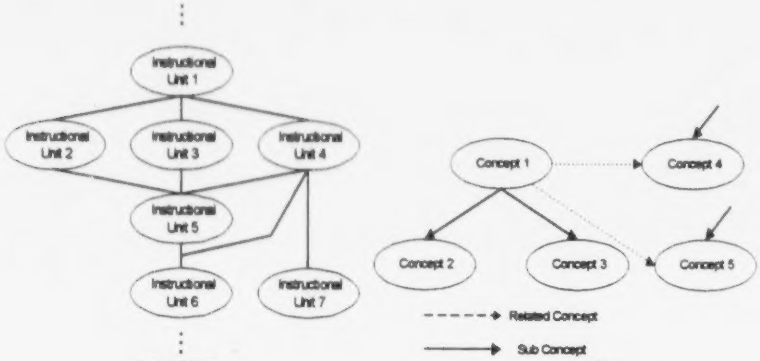
The domain knowledge will be used in coaching the students, diagnosing possible misconceptions after a student has made an error, and providing appropriate remedial materials. This domain model has dual representation network, the IUN(Instructional Unit Network) and the CN(Conceptual Network).

The IUN is a knowledge network which includes the materials to be shown to the student and the information concerned with learning sequence. The IUN is configured as a hierarchical network, and each node of it has the link to the subordinate unit and the subordinate unit denotes the prerequisite knowledge of the super unit.

Within the IUN, each node represents a learning unit, and it includes the theme of units, learning aim, the link of the concepts related to the learning units, the links to the problems, and the links to the subordinate units.

There are two types of the instructional unit. One is the explain unit, the other is the problem unit. The explain unit has instructional materials that have various media types such as text, graphic, still image, sound, and moving picture. The problem unit has two major concept to diagnosing the student's state, difficulty and importance. These concepts are used when lesson planning and gradual instruction objective creating. [Fig. 2(a)] represents an example of the IUN.

[Fig. 2(b)] represents an example of the CN. The CN is a knowledge network which piles up the knowledge of being contained in subject domain to be learned by the student. The CN is a data structure, which is a set of collected knowledge concerned with the declaring concept of domain knowledge, but independent upon the instructional knowledge. Each node within the CN represents the instructional concept, and the links between the concepts indicate the relationship of them. Using this relations, it is possible to generate problem dynamically, and to diagnose the student's error.



(a) IUN (b) CN

Figure 2: Examples of the IUN and the CN

According to environments of the CORBA, expert module can access CORBA ORB(Object Request Broker) to assist easy retrieval of materials, and URL indexing and caching demon to improve performance of system.

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Unlike existing stand-alone ITS, user verification have to be supported so as to provide the individual learning according to the rate of each student. But HTTP can't support the method of user verification. When the first node is transmitted to the student, student account and password which are transmitted to the authorizing processor is transmitted into explaining node as a hidden tag. When the student requests the next node, the system can verify the students by the student account and password tag which are transmitted to student module.

3.3 Student module

This diagnostic result generated by student module is used by the instructional strategy module in order to inference the basis for determination of learning progress, supplying advice, and selecting comments.

In this paper, the student module is based on the overlay model. The student's knowledge has been learned is saved at the database within the student module, and the learning path can be shown in parallel with the learning achievement. As the learning proceeds, the student knowledge network in the database has the network form which is similar to the IUN as a knowledge base of the expert system. The diagnostic results of the student, problem type, and examples are saved at nodes in the student knowledge network. And the form of student knowledge network represents the learning path.

When the domain knowledge expert constructs the IUN and the CN by means of authoring interface, the two networks contain slots represented by linguistic variables for holding importance and difficulty which are the attributes of each problem and instructional unit. The linguistic variables used in input are shown in [Table 1].

Table 1: Linguistic Variable for Diagnosis

	Instructional unit	Diagnosis result
difficulty	D, M, E	G, M, B
importance	I, M, Ni	
modifier	[Very]*, [Less]*	

* where D = Difficult, M = Medium, E = Easy,
I = Important, Ni = Not Important, G = Good, B = Bad

The linguistic variables about the problem are used for diagnosing student's response. Using the linguistic variables, the domain expert can input at more user-friend environment because of being able to use linguistic variable and no need to decide special real number for attributes of all learning elements. The linguistic variable is the kernel of fuzzy theory which makes use of the fuzzy representation of human-being in computer. Using the concentration and dilation in the fuzzy theory, we can define the function which diagnoses the student's current knowledge. The function of concentration and dilation are as follows.

$$CON(A) = A^2 = \sum_{i=1}^{n} \{x_i, m_A(x_i)^2\}, \forall x_i \subset U$$

$$DIL(A) = A^{\frac{1}{2}} = \sum_{i=1}^{n} \{x_i, m_A(x_i)^{\frac{1}{2}}\}, \forall x_i \subset U$$

The membership functions upon Good, Medium, and Bad may be changed by the author, and the diagnostic results can also vary according to the membership function applied. Hence, the author can control the diagnostic results by changing these three membership functions.

The difficulty and the importance of [Table 1] are defined as the dilation of Medium(the default membership function of M is M=x), and both Easy and Not Important are defined as the concentration of Medium.

$$D = I = M^{\frac{1}{2}} = DIL(M)$$

$$E = Ni = M^2 = CON(M)$$

Therefore, we can define the DV(Diagnostic Value) function as follows.

$$DV(R_{1-n}) = norm\left(\sum_{i=1}^{n} (R_c/R_n)^k\right)$$

norm : normalization function that makes the result in the range of [0,1]
R1-n : The problem from start to n that was responded by student.
Rc : The number of correct answer according to linguistic variable
Rn : Total number of problems presented to student
k : The number of powers according to linguistic variable, defined as follows: I or D : ½, M : 1, Ni or E : 2

Normalization is defined as follows: suppose that all problem is correct, then, calculate the DV and divide into the result of calculation about correct answer. If the importance and the difficulty are applied at the same time to the same problem, select one that minimizes the membership degree and applies it.

To use more various values for representing the importance or the difficulty, we must consider modifiers applicable to the linguistic variables. In this paper we define two modifiers, Very and Little, as follows

$$V^nD = M^{\frac{1}{2^{n+1}}},\ L^nD = M^{\frac{1}{n\sqrt{2}}},\ V^nE = M^{2^{n+1}},\ L^nE = M^{n\sqrt{2}}$$

The equations above always hold the relation

$$V^nE \le L^nE \le M \le L^nD \le V^nD \quad (n \ge 0)$$

regardless of its number of repetition. Hence, the inconsistency of diagnostic result caused by repeated applications of the modifier is removed. For example, Easy is never less than Very Easy in spite of the number of Little modifier's applications.

The calculation result by DV function for the diagnosis of student's response is a real number which ranges between zero and one. To execute fuzzy inference using linguistic variable, result obtained by the DV function has to be fuzzified. Fuzzified result is one of the linguistic variable that consists of Good, Medium, Bad, and the modifier [Very]*, [Less]*.

If we fuzzify the diagnostic results into the linguistic variables, then they can be used together with the inference rules using the linguistic variables. [Fig. 3] represents the district graph of diagnostic value to fuzzify diagnosed result.

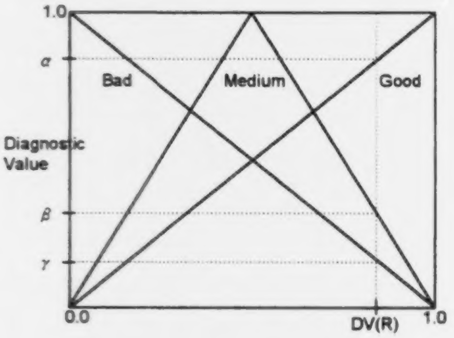

Figure 3: District graph of DV

If the author input the inference rule and there was conflicting among those rules, that is, different result is input at the same condition, the author is presented the condition and is asked what result should be used. The result of learning, whether well or poor, is determined according to what deterministic variable is input by the author. This shows that the author's intention is able to be reflected to inference rule.

3.4 Instructional strategy module

The instructional strategy module mediates and develops the learning of the students through the planning of a curriculum to order the domain knowledge that must be supplied to students, and the planning of teaching to decide the presentation method, re-planning to construct proper planning and monitor the action of students.

Among the contents of a lesson which are taught to the students, the total contents of a lesson are composed of the network of the main objectives of instructions that are relatively independent each other.

Lesson plan presents the evaluation problem and the instructional material of instructional unit, decided by the curriculum planning to students in the proper level. The Instructional strategy module offers students the instructional material on the instruction unit and the evaluation problem by means of the method divided by the curriculum planning.

The gradual instruction objective must be created by considering the student level that has acquired the degree of difficulty of instruction unit and students' records obtained previously. For an efficient instruction, problem presentation order must be planned dynamically by according to the students' level. The instructional strategy module can create dynamically the problem about the concept learning and the discrimination learning using the CN.

Also instructional strategy module can dynamically limit the number of links which the student can select, according to the level of each student. This module have functions which provide the students for advice when the students refer the irrelevant to the present learning content frequently or when disorientation problem occurs.

4. Conclusion

Existing distance learning systems has poor support for not only interaction with students, but also individual instructions. And researches that overcome disorientation problem in vast hypermedia space are very few. In this paper, we have designed and implemented intelligent distance learning system which supports interaction with students, can create dynamic instructional strategies. Our system consists of expert module, student module and instructional strategy module. Because our system has data structure and method that diagnoses students' knowledge, it is possible to plan lessons dynamically.

Student module can support interaction with students using CGI applications on the WWW, diagnose each student's knowledge using private student's information and students' response. In instructional strategy module, evaluation problem can be created dynamically according to the diagnosed result, individual instruction can be supported by deciding further instructional strategy. In expert module, student can recognize himself in courseware WWW on instructional unit network. So, we can overcome disorientation problem.

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COMPUTER ASSISTED LEARNING IN CASE STUDY

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Abstract: Case study is a well-recognized teaching and learning method, which has been extensively used in a broad range of fields, such as Information Technology, Operations Management, Business Process Re-engineering. However, many real world cases which are widely used in case studies are difficult for students to understand and to participate in the study, either because the information provided is too abstract, or not all students can join the discussion. Thus very often, in the limited study time, optimum learning results are not achieved. In this paper, we present a method to introduce Computer Assisted Learning (CAL) into case studies. The main objectives are to improve students understandings of a case, and also to increase the effectiveness and efficiency of their learning. Unlike traditional case study, the setting of our approach is mainly on one-to-one basis rather than in group. The initial evaluation of our approach is also presented in the paper, and the problems with many current CAL software are also discussed.

INTRODUCTION

Traditional teaching through lectures alone is no longer sufficient for good student learning. Teaching students especially in big class is not an easy task due to their different levels of learning abilities, and it lacks communications. In addition, certain aspects of subjects may be difficult for students to learn merely with lectures and textbooks. Therefore, lots of effort is usually required to smooth the knowledge building after lecture through tutorials or seminars.

To improve the quality of teaching and learning, many innovative measures have been introduced into traditional teaching method, such as radio, TV, and computer-assisted instructions. Especially in recent years, with the advances in multimedia technologies, many computer assisted teaching and learning applications emerged [Blevis 1991][Kass 1991][Edelson, 1993]. However, most of these applications focused on presentation of course materials rather than on mutual communications, and thus have little impact on the quality of student learning. A phenomena as pointed out by Adam [Adam 1993], "The content of instruction, not the means of its conveyance is what influences performance results." Such phenomena indicates that there is a lack of consensus on the essential architecture elements of an educational system.

Instead of setting our goal on building generic principles about the design of educational systems, in this project, we mainly concentrate on case studies, which are usually conducted after lectures. A case study normally involves more discussion, i.e. more interactions, than in a lecture. Thus, a successful educational model built on case study would be highly representative in building of an educational system for teaching and learning.

PROBLEMS WITH CURRENT EDUCATIONAL SOFTWARE

Schank [Schank 1993] explains that the dominant educational paradigm in computer based instruction has been what can best be described as "page-turning architecture," and therefore, they asked students to do little more than "press button for next page" for video or graphics. Such software shows no creativity in terms of innovative educational method, and exposes lack of understanding of the problems with current education system among those developers. This is in line with Scardamalia's comments [Scardamalia 1993], who says "Traditional knowledge reproduction strategies limited potential for advancing knowledge, and often are not even very effective for purposes of memorization and organization of knowledge." He regards that the most conspicuous failure of those educational software is in the development of understanding.

Creating educationally effective multimedia software means taking seriously the idea of learning by doing, and focusing on understanding and supported learning in entirely new ways, with vital attention to the skills of social interaction and participation. Pea [Pea 1993] points out, "In contrast to learning-before-doing, which is the model of most educational settings, learning-by-doing is a model in which learners are increasingly involved in the authentic practices of communities through learning conversations and activities involving expert practitioners, educators, and peers." Thus, good educational software is active, not passive, and ensures that users are doing, not simply watching.

CHARACTERISTICS OF CASE STUDIES

Case study is a well-recognized teaching and learning method, which has been extensively used in a broad range of fields, such as Information Technology, Operations Management, Business Process Re-engineering. A good case study would allow students to be inquisitive and effectively master the course materials through interactions and participation in discussions. Such practice has proved to be very successful in the past. However, there are also shortcomings. First, some real world cases are difficult for students to understand and to participate in the study, because the information provided is sometimes too abstract. In particular, for those cases which students are not familiar with, students can hardly understand them without showing them the actual settings. Secondly, in group study, not all students may join the discussion, especially those inactive students. Thus very often, in the limited study time, the optimum learning results are not achieved.

COMPUTER-ASSISTED APPROACH

In our Business Faculty, case studies are widely used in several major courses, such as Marketing Management and Information Systems Management. The initial development was concentrated on the course of Marketing Management. The software package developed at its current form is not only for case studies, it also can be used by students for course review, as it contains most of the course materials, though the emphasis was put on case studies.

There are mainly two innovations in our approach. First, multimedia technologies were used to present real world cases in realistic settings through computers. Such method can convey sufficient materials to students in comparatively shorter time. It also gives students a stronger impression about the settings, and thus allow them to be involved more actively in the study later on. Second, such case studies can be conducted on one to one basis, not necessarily in group, because the package was incorporated with questions, feedback, and suggested answers in multimedia form. By so doing, students will have the option of recovery from failure by asking persistent questions and mastering the material before moving on without embarrassment, thus individualized attention is achieved.

There were two main challenges encountered so far. The first challenge was to produce the video clips which show the real world settings of the cases selected. The second one was to prepare the anticipated questions which might arise and to have previously videotaped and catalogued the answers to these questions. Both of these issues are critical for the success of a case study software.

EVALUATIONS AND FURTHER WORK

The multimedia software developed has been used on trial by selected students for Beta test on an individual basis. The results of our initial evaluation were encouraging. In particular, the following features of our package were found very useful. First, the set of buttons, such as Why, How, What, Too Hard, No Way, and Boring, which allow a student to stop anything that is going on and find out what he/she needs to know, were very useful. Second, the difficulties of the questions provided were appropriate (only satisfactory answers will lead to the next session). Third, different methods of presentation of same materials for different levels of students, i.e. Hard, Medium and Easy, were helpful. Fourth, system logs to monitor the progress of students, in particular regarding poor performance records, is necessary.

Formal evaluation is yet to be conducted through interviews, questionnaires and analysis with both lecturers and students in order to refine the software. Then, a statistical experimental design will be developed to evaluate and compare the learning effectiveness of the traditional case studies and our new approach.

CONCLUSIONS

Through this research, it is intended to study whether computer assisted learning can be used in a highly interactive educational environment, i.e. case study. The main objectives are to improve students understandings of a case, and also to increase the effectiveness and efficiency of their learning. The initial evaluation of our approach was conducted, and the results were encouraging. In general, it has proved so far, computer assisted case study is possible. This research will also help us to build a common framework of an all encompassing task that achieve the optimum result of understanding, which incorporates the essential architecture elements that should be considered in building an education system.

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A Study of the Multimedia Design and Production Process
By the Practitioners

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Abstract: In this presentation, we report a study conducted with the practitioners in the multimedia industry on the design and production process they have used. It is our purpose to provide useful information on what the multimedia production process is, and how people in the industry design and produce multimedia programs. It is intended to inform interested people, especially students who want to take a career in multimedia, about how to get better prepared for the multimedia job market.

Rationale of the Study

We are experiencing dramatic changes in all aspects of our life brought by the advancement of technology. Technology plays a prominent role in determining what we learn and how we learn. New technologies such as interactive multimedia and telecommunication have revolutionized the process of information presentation and information construction. Multimedia programs have been developed and used in all content areas and at all levels of schooling. In the past few years, the use of multimedia CD titles have increased tremendously both in education and in industry [Lee, 1995]. With the popularity of World Wide Web, it is foreseeable that interactive multimedia technology will have more influence on the way we communicate information and on our learning.

The rapid growing market of multimedia has created a great need for multimedia designers and developers. Many multimedia companies have been formed, many college graduates have entered the multimedia business and many more students wish to become a multimedia designer or developer. Because the technology is relatively new and is changing rapidly, our understanding of the development process is still limited. Little was found in the literature on this topic. Although students at universities may gain a solid foundation in instructional design theories and technical skills in using technologies, the actual development processes for successfully producing an instructional program are not always readily apparent or accessible to students [Gentry, 1994; Greer, 1992]. There is often a gap between what is taught in an academic setting and what is practiced in the real-world. Students often lack the competence in professional practice which requires practical knowledge involving know-how and insight learned through practice [Quinn, 1994]. Therefore, students who want to enter this growing job market are often not well-prepared in that respect. How does the multimedia process work? How to design and produce a quality multimedia program? More importantly, how can students be better prepared for this growing market?

Purpose of the Study

The purpose of this study is to find out the multimedia design and production process from the practitioners, who are involved in it every day. Our research questions were:

1) How does the multimedia production process work?
2) What are the critical aspects in the multimedia development to ensure the quality of the programs?

3) What different roles do people play in multimedia development and the relationships of these roles to the entire process?
4) What can students interested in multimedia do to prepare themselves for the job market?

Method

To answer the research questions proposed, we sought to interview the multimedia practitioners who are involved in developing multimedia programs from Austin, Texas. Austin is known for its advancement in computer technology. It houses major technology companies such as Apple, Dell, IBM, MCC, Motorola, Samsung, and Texas Instruments as well as many smaller technology companies. Austin has a very active multimedia community which supports award-winning companies as well as start-up companies.

About Interviewees

We sought to interview those companies that were involved in developing educational multimedia titles in the Austin area. Ten companies were identified using a multimedia directory compiled by Texas Government office. Because our goal was to understand the production process for developing educational materials, we chose not to interview those companies that developed entertainment programs only. Fourteen multimedia developers with different backgrounds were contacted, and interviewed.

All of the sixteen interviewees were working on instructional and interactive multimedia projects at the time of the interviews. A number of the interviewees had contributed to award-winning multimedia titles. Eight were females and eight were males. They came from various backgrounds such as radio-TV-film, computer science, fine arts, physics, or instructional technology. Some had a bachelor degree while others had a master degree. All of them had years of experience in designing and developing multimedia products, and assumed different roles in their companies (i.e. the role of a project manager, an instructional designer, a programmer, a graphic, artist, an animator, a permission specialist, or a videographer). With their experiences and backgrounds, these multimedia developers were able to discuss the process of developing multimedia projects from several perspectives: (a) that of someone who oversees the entire process, (b) that of someone who is in charge of his or her department but reports to the project manager, (c) that of someone who plays a specific role in the entire process such as a permission specialist.

The Development of the Interview Questions

The four research questions formed the focus of our inquiry. Using these research questions as the starting point, we proceeded to develop a series of interview questions. The development of the interview questions was based upon the synthesis of the few published literature on the topic [Apple Computer Inc, 1994; Josephson & Gorman, 1996]. Initially questions on various aspects of multimedia were developed, which included questions on fact-checking, project management, authoring, programming, and graphics. Using these questions, three preliminary interviews were conducted with the multimedia developers from a medium sized company. The purpose of conducting the preliminary interviews was to confirm the importance and appropriateness of the interview questions, and to ensure the questions developed would help to answer the four research questions. Based upon the data gathered from these three preliminary interviews, the interview questions were revised and refined. The final interview questions consisted of questions on 12 aspects of multimedia production process: (1) general questions, (2) fact-checking question; (3) authorer questions; (4) permissions questions; (5) project manager questions; (6) programmer questions; (7) artist questions; (8) animator questions; (9) instructional designer questions; (10) writer/editor questions; (11) videographer questions; (12) audiographer questions. The number of questions within each aspect varied, ranging from three question in one aspect to 29 questions in another. Some sample questions included: What is role of your department in the multimedia process?, what kind of expertise do you look for in hiring new people for your department?, what are some of the major obstacles you face in doing your job?, How do you coordinate with instructional designers?, How do you acquire contracts? In what do you utilize user-testing?, How much of the screen do you reserve for text? When is voice-over utilized over text? and who is responsible for the script and storyboard of the video? The interview questions will be shared with conference participants.

Procedures

Once the questions were finalized, contacts were made with the potential interviewees in Austin area to find out if they were willing to participate in the interviews. We conducted the interviews with people who played different roles in the production process such as the manager, the programmer, the artist, the animator, or the videographer. A total of sixteen interviews were conducted from ten different companies. These interviews ranged from 15 minutes to 1 hour and 15 minutes in length with an average of 45 minutes depending on the available schedule of the interviewees. In addition to the specific questions regarding his or her role (e.g. animator), each interviewee was asked general questions such as the design and production process used in his or her company, the division of roles, important aspects and tips for producing multimedia. Interviewees were also asked to describe their professional and educational backgrounds.

Data Analysis

The interview data was first transcribed, then chunked, coded and categorized following Miles and Huberman's guideline (1994). A list of codes were first generated directly from the data. During the coding processing, the codes were refined, revised, and new codes for emerging themes were added. Patterns from the data were extracted and the relationships between the coded segments were compared and contrasted. The data was then sorted into categories and sub-categories according to their common themes and shared relationships. Finally the codes along with their themes were placed within the four research questions. Three researchers were involved in this data coding and analysis process. Each researcher independently coded the data. Disagreements among the researchers were discussed and resolved after reexamination of the data until a .98 interrater reliability was achieved.

Result and Discussion

Multimedia Development Process

The interview data revealed that the multimedia development process, though varied from company to company, consisted of these six main phases: (a) funding, (b) planning, (c) designing, (d), production, (e) testing, and (f) marketing (see Table 1). Each of the phases has a number of activities. The phases represented the process from the inception of an idea to the finished product. Very often companies worked on several projects simultaneously and usually the projects were at the different phases for a particular period of time. The project manager had the responsibility to ensure all people involved in the project to stay on task and complete their part by the specified deadline.

For the companies interviewed, most of the work was obtained through a contract from a client. The client could be a major publisher, a state or federal agency, or a company. They often obtained these contracts through submitting proposals to "Request for Proposals" sent out by the client [McDaniel & Liu, 1996]. Some work was obtained through personal contacts or the referrals by other companies. Obtaining funding was a critical phase for most small multimedia companies. Therefore, the interviewees stated that they took it seriously. They mentioned that producing quality work would help to establish their reputation so that the client may return the next time. Once the contract was secured, a series of negotiations began between the developer and the client. These experienced developers mentioned that it was very important to discuss the ownership of the content, the project schedule, and payment during the negotiation. Sometimes, the developer received the content from the client who owned the copyright and other times the developer had to generate new materials from scratch. The developer and the client also needed to agree on the completion dates for various phases to ensure the feasibility of the intended amount of work. The budget was also discussed at this point. A prototype was then developed to see if it would satisfy the client's needs. Based upon the client's feedback, various specification documents were developed which provided detailed information on content, design, interface, functions of the product. Flowcharts and storyboards were created to reflect the specifications. The production phase then began, which was followed by testing and marketing the product.

Roles and Responsibility

Developing a multimedia product called for creative work from many different talents such as a project manager, an instructional designer, an authorer/programmer, an artist, an animator, a writer, a videographer, an audiographer, a subject matter expert, and a permission specialist. The collaboration among these people contributed to a successful finished product. As the technology evolved, these roles within multimedia companies had been developed accordingly. Depending on the size of the company, the roles might be expanded into departments or one person might play more than one role.

Throughout the creation of a multimedia project, the roles within the company must be in constant communication in order to create consistency in the design and focus of the end product. The interview data showed that the project manager had the primary responsibility of negotiating with the client, and outlining the objectives, scope, schedule, and funding for the project. All different roles often provided their input into the vision of the project during the planning phase, which helped to ensure all roles had a central vision and were working toward a common goal. The expertise from the different talents was vital in determining whether certain design elements were feasible within the guidelines of the project. The instructional designers often assisted the project manager in creating specifications. Once the client and project manager agreed on the content and scope of the project, the instructional designer created storyboards or design specifications for the project. Most of the roles were involved in the production process. The artist was creating graphics, the animator was designing the animation, the writer was writing scripts, the videographer was collecting and digitizing video, the audiographer was casting, creating, or purchasing sound, the subject matter expert was checking the content validity, and the permission specialist was searching for and obtaining copyrights. As the production phase progressed, the authorers /programmers began to stitch together the elements of the piece and program the functionality of the project. Once the production phase was coming to a close, many of the roles remained on the project in order to revise the project based on client feedback, evaluations, alpha testing, and beta testing. After the production phase, the project manager continued to oversee the project, communicate with the client, and see the project to its completion.

Development Phases	Corresponding Activities
Funding	• writing proposals • responding to "Request for Proposals" (RFP) • writing grants • joining competitions • obtaining contracts through personal contacts, referrals, and demonstration of what one can do
Planning	• negotiating with the client on scheduling, budget, and scope • finding out what the client wants • brainstorming • deciding on the objectives, presentation styles, delivery platform • creating a prototype • getting feedback from the client
Designing	• creating documents specifying the design, content, function, interface • creating flowcharts and storyboards • creating timelines and identifying major milestones (deadlines for a particular phase) • distributing work among different roles (designer, programmer, artist, animator, videographer, audiographer, permission specialist)
Production	• programming • writing scripts • creating artwork • creating animation, video and audio • creating interface • putting together all pieces
Testing	• getting feedback internally • getting feedback from the client • getting feedback from users • revising and debugging
Marketing	• distributing the product

Table 1. Major Phases of Multimedia Development by the Practitioners

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Factors Contributing to Successful Multimedia Development

Several factors outlined by the interviewees contribute to the success of a multimedia project. These factors are (a) constant and smooth communication among all people involved in the process, (b) taking advantage of all the talents, (c) continuous evaluation and feedback, and (d) on task and on schedule. Because multimedia development involved many different roles. Communication among all parties involved was important. Most interviewees mentioned that they maintained weekly meetings among the team and regular informal conversations. Such constant communication between each other helped to keep everyone on track and prevent problems earlier on as one interviewee stated. The interviewed companies used the technique of brainstorming to get creative ideas from all those involved in the project, whether they were programmers, artists or designers. One project manager said, "We try to get everyone's input because we have a lot of creative people on staff... I am constantly amazed by the ideas that people come up with -- things that I never though of." A project manager must not only be open-minded, but also very efficient and effective. Most projects had a very tight deadline and involved many different people. The manager had the responsibility to keep people on task and ensure the deadlines were met. When asked what would constitute good quality for doing multimedia, a developer said, "the ability to deliver on time and the quality of the work." All interviewees discussed the various stages of testing they used. They were a prototype, an alpha, a beta and a final testing. They emphasized the testing process was not one stage occurring at the end of the development process, but a continuous process occurring at almost all phases [Dick & Carey, 1996; McDaniel & Liu, 1996]. It was a critical phase to ensure the quality of a product and the product would meet the client's needs. Although multiple cycles of formative evaluation were used, the interviewees also mentioned that the summative evaluation seldom occurred. The reasons were often there was a lack of the funding, and the developers had little control over the product when it was delivered to the client.

Hardware and Software

The platform of choice for most multimedia developers was the Macintosh, though one developer used the PC exclusively. Most developers also used PC's to cross-platform their products. Either large or multiple monitors could facilitate ease of development. Macromedia *Director* was the most popular authoring tool cited by the developers interviewed; *Authorware* was also popular, while *Toolbook* was used by the interviewee who developed exclusively on the PC. *Photoshop* was the most commonly used graphics tool. *CorelDraw*, *PaintShop Pro*, *After Effects*, *Adobe Premier*, *Fractal Design Painter*, and *Infini-D* were also used. Programmers were typically expected to know the scripting language in Macromedia *Director* called Lingo, and/or C++.

Tips and Techniques

In the course of the interviews, the developers offered a variety of tips about successful multimedia development. The following included only a sample of the more common suggestions provided by the interviewees.

Planning. Planning is the key to the success of most business endeavors, and this is certainly true in multimedia, where a lack of planning early in the process can be costly in terms of time later. All developers emphasized the importance of planning, and some offered specific suggestions. A videographer explained the need to carefully prepare for post-production while on location: "In the post-production environment, if there is something missing like an ambient audio, you're long past the time you're in production and can just say, 'It would be nice to have this particular shot or this particular audio sound.' In an expensive post-production house, where it would be like two hundred dollars an hour, you have to be extremely prepared or your money is just going down the drain." Some developers pointed out that when a great deal of up-front planning has been done with the client, it is easier to consider changes that the client requests at a later time as change orders, and therefore, the client must pay for the time to make these changes. Some recommended careful planning of the amount of data that would be generated for graphics, text, audio, and video so that the final product does not exceed the 640 MB of memory available on a CD ROM. Another good suggestion made by some interviewees is that it is important to get everybody, project manager, lead instructional designer, art director, video/audio director involved early in the process so as to "avoid pitfalls along the way," because these people what is possible and what is not possible from their perspectives. Finally, early testing on target machines, i.e. the range of machines that are expected to be able to run the final product, will help to guide the choice of media and activities designed for the product.

Time management Skill in managing time in a multimedia environment is based on experience. Two specific suggestions relating to managing the schedule of a project, offered by the interviewees, are: First, in creating the schedule, plan on unexpected problems to arise near the end of the project. "There's a 9 to 10 rule. Supposedly when you have 10% left to do, you really have 90% of it - because that is when all the major stuff happens. So, try to stay ahead of your schedule." A second suggestion is to insert milestones throughout the project. This keeps everyone working toward common goals and deadlines and create a time when people can celebrate their accomplishments throughout the project.

Personnel. Multimedia businesses depend upon the talent of their employees. Therefore, it is important to build a visual, and creative staff. Large businesses may departmentalize, allowing employees to develop talents in one area only, but small companies should look for multi-talented people who can perform a variety of jobs. The staff should constantly seek out and share information about advancement in technologies.

Resources. Effective management of time through careful planning is a key to success. Skill in managing time in a multimedia environment is based on experience. One developer, for example, stressed that experience in post-production as invaluable to ensure all relevant materials are collected during video shooting and avoid wasting time and money for redoing. Another developer cautioned project managers to be realistic about time, and to stay ahead of schedule, because unexpected problems always arise near the end of a project.

Communication with Clients. Because many clients lack a familiarity with multimedia, the importance of educating the client as to the design, capabilities, and costs involved in multimedia development is critical. In case of disagreements with the client on issues of content and design, it is important to remain diplomatic, to attempt to convince the client of the reasons for a differing position, and to abide by the client's final decision. Because clients can occasionally disappear or fail to pay, it is advisable to require the client to pay ahead of time or upon delivery.

The findings of the study provide information on the multimedia development process from a practitioner's perspective. They help to clarify the mystery of what is involved in multimedia production and provide useful tips and techniques from the multimedia professionals. As more jobs focus on the technology of the Information Age, many individuals will be turning toward multimedia as a means of communication, entertainment, and instruction. How can an individual get prepared for the multimedia business? Education is certainly one way to gain entry into multimedia. In addition to taking courses in multimedia offered by universities and colleges, an individual who wants to enter the field should surround themselves with creative stimuli, since multimedia production is a creative, fast-pace, and ever-changing endeavor. A person who wishes to create multimedia products must be prepared, both mentally and physically, for a steep learning curve of the multimedia production process and the software and hardware involved. They should master a state-of-art authoring platform and some of key software used in multimedia development. They should read books and trade magazines frequently in order to understand the theory, the vocabulary, and keep up with the development of the technology. They should be ready to learn constantly as new developments continue to develop in this ever-changing field. More importantly, they should seek opportunities to get involved in the hands-on experiences. An internship or part-time job with a local multimedia company will be very beneficial. Lastly, they should be prepared to sacrifice and spend long hours. Some developers spent over 100 hours per week when working on a project and others spent 40 hours per week. Regardless, multimedia development is an exciting field, as one interviewee put it, "you get paid to have fun."

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Computer Mediated Communication in Higher Education: A Dual Perspective

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Abstract: This paper examines some of the potentially problematic areas raised by the provision of Computer Mediated Communication (CMC). The author uses his dual perspective as developer and participant to highlight issues including: the level to which the medium can mask the message; the importance of student motivation and the nature of the group dynamic; the phenomenon of the 'lurking' student; and the role of the tutor-facilitator. These are then placed in context alongside the traditional campus-based teaching paradigm, with the relationship between the increasing use of learning technologies and the nature of traditional campus based teaching also considered. While the issues chosen emphasise some of the potential problems raised by CMC, the author approaches the topic from the standpoint of a CMC convert who firmly believes that the educational experience provided by CMC can be every bit as rich for online students as for their campus based colleagues.

The Impact of CMC

The advent of the information revolution has created a vast new arena of educational opportunities, among the most notable of which is the provision of education at a distance. For that growing section of the educational audience that wishes to study away from the rigidly bounded structures of a campus based degree course, the time and place independent nature of Computer Mediated Communication (CMC) offers a near perfect alternative.

While the nature of CMC varies across a number of alternative forms, ranging from the simplest of electronic mail supported programmes to those which utilise dedicated computer conferencing software, the core element shared by all these options remains constant; the emphasis they place upon the notion of student-centred, open learning. CMC then, in any of its established forms, offers the student an opportunity to take responsibility for their own learning process.

In the 'confusion' of terminologies that has grown up around the educational use of technology, this extension of the notion of truly 'open' learning encompasses all that is positive about the desire to broaden access to education. CMC provides an outlet for a previously disenfranchised section of the learning community and has the interesting ancillary benefit for institutions, under pressure to recruit ever larger cohorts of students, of providing an entirely new 'market' opening for their courses. The opportunity CMC presents in the effort to exploit additional student 'markets' may be one of the central features that defines the ongoing development and implementation of this and other learning technologies.

The asynchronous nature of CMC allows prospective students to consider undertaking a course of study while limiting the disruption caused in other aspects of their lives, most notably familial and employment. This allows individuals to take control of their own learning process, deciding when, where and if to study. This method is by no means new, with correspondence based distance education very much an option for those who cannot study via traditional methods. Yet it is the advent of educational exploitation of technology which has made this type of course both more accessible and more attractive to the 'customers'. With this type of student in mind there are two main markets, existing at opposite ends of the higher education spectrum. Among the most exciting niches for the exploitation of such technology one can consider the potential for extending professional development and post-graduate programmes, both of which cater for groups of students whose motivation to study, it is hoped, would ensure they were pre-disposed to adapt more readily to the rather different rigours of the learning environment provided by CMC. At the other end of the scale are pre-undergraduate programmes enabling those without traditional entry qualifications the opportunity to gain 'access' to University. This too is an area where an alternative method of study may help to make the choice over whether or not to return to education much easier.

While the student-centred, technology-based, distance model of educational provision clearly challenges the traditional paradigm of campus bound education, it is the purpose of this paper to emphasise that while the experience of both staff and students is significantly different, it need not be an inferior experience. Indeed, with careful planning and the required level of commitment on behalf of staff and students, there is nothing to prevent the experience becoming even more rewarding than its traditional counterpart.

The Dual Perspective

In November of 1995, the Distance Education Online Symposium Listserv (DEOS-L) highlighted a forthcoming Workshop to be hosted by Monash-Gippsland University, Australia. The Workshop was designed to benefit those who were either involved in, or looking to move into, the field of, online provision of courses. The rationale behind the venture was to offer interested parties the useful experience of active participation in a conference, thus providing the ideal opportunity to experience the realities of life as a geographically and time challenged learner prior to running an online venture of ones own. Given the benefit of this experience it was hoped that the participants would be fully cognisant of the rigours of that which they would seek to 'inflict' upon others.

For those who participated fully in all aspects of the Workshop, involvement was both enjoyable and informative, with much of the discussion centred on the future direction of CMC and distance education. Unfortunately a relatively high attrition rate was experienced and thus only a hard core of survivors were left to enjoy the full benefits of this activity.

As a developer, the author has become involved in the evaluation of online seminars within the teaching of Politics and International Relations at the University of Aberdeen. As a means of assessing the utility of this method of delivery, a simple electronic mail package (tailored for the purposes of the seminar) was used in conjunction with the World Wide Web (WWW) to provide a basic forum within which a discussion of the topic could be conducted among a volunteer group of students, participating as and when they wished. Briefing materials were housed at a password protected WWW page, and the discussion itself was conducted via a user-friendly, user-configurable electronic mail package (Simeon). A comprehensive package of materials to aid the students' orientation prior to participation was also developed, including guidelines for the number and frequency of their inputs to the discussion, as well as including details of the various deadlines set for rounds of participation. The rationale behind this project was to investigate the potential for such facilities on a broader scale, with a view towards the possible implementation of CMC teaching on a modified or new postgraduate Masters module. This was coloured by the need to remain wary of the cost factor, with the entire venture very much experimental at this early stage.

That said, the seminars conducted via this system were full of thoughtful contributions and suggested to all concerned that this was an avenue worthy of further consideration should a decision be made at a University level that such projects would be recognised for degree accreditation purposes.

The Pitfalls of CMC

The broad trends which had become apparent as a participant in the Monash Workshop, were further corroborated by involvement in this venture and are notably referred to consistently throughout the body of the distance education literature. It is the combination of the author's dual experiences of participation and facilitation in a CMC framework, and the potential hurdles that these helped to highlight, which informs much of this paper. Thus, this paper reinforces the belief that there are several key issues which lie at the heart of CMC development, and remain issues which anyone becoming involved in such an activity will be forced to deal with.

Before going on to examine the issues raised, it is worth emphasising once again that both activities were entirely voluntary. This undoubtedly exacerbated some of the problems encountered, most notably the willingness of various individuals within the respective groups to participate fully given the additional commitments of work, impending assessments and other demands on time. That said, the voluntary basis of such activities could have been a more pervasive element of both activities than was actually the case, with those who demonstrated the motivation to participate gaining much from the activities. In any event, this is an issue that the additional motivation generated by factors such as: the desire to gain a qualification; impending examinations in the subject; and the financial cost of participation, would surely help to ameliorate. All of these factors suggest that when used for the delivery of degree course options, an additional level of motivation would, at least in theory, be guaranteed.

CMC Issues Raised

As suggested above, several issues came to the author's attention, highlighting problems which are commonly encountered in the development and provision of CMC. These included:

Obscuring the Message with the Medium

The first issue which any CMC provider encounters is that the learning environment their students will be expected to learn within is, in general, alien to them. This has two facets: the first is a consequence of the technology itself which can, if incorrectly utilised, cause the students additional problems over and above any they might encounter with the academic aspects of the course and the learning material itself; the second, which is considered later, relates to participation in a course taught via CMC, which may have no face-to-face interaction of any kind (be it either student-student or tutor-student contact). Either or both of these can affect student motivation, feelings of isolation and, if bad enough, may lead to high drop out rates.

While feelings of social isolation may be an unavoidable danger of even the most carefully tailored CMC package, the level of technological proficiency required to participate effectively within the forum should not and as a result is something that can be countered by course developers.

While techno-phobia is something that will gradually become less problematic as the reach of communications technologies gradually pervades all of our working and private lives, there still exists an element (perhaps more so in the UK) for whom the internet and electronic mail remain a mystery. As a consequence, this may undermine their ability to exploit the educational opportunities we seek to make more broadly available via these technologies.

The most logical way to avoid (or minimise the impact of) this, is to keep the medium as user-friendly and as simple as possible. This should then be coupled to a comprehensive set of instructions on how to use and configure the system. This preparation and support prior to participation is documented as crucial to the success of the venture [Hartley et al. 1994] and ensures that students are not left battling their ignorance of technology as well as the course work. Thus whether a simple electronic mail package is used (as in the pilot seminars run in Aberdeen) or a designated conferencing system, a key feature in successful implementation is a concerted effort on behalf of developers to ensure the systems employed do not unnecessarily obfuscate the actual learning interface, with one way of helping to guarantee this being some mechanism via which the students can establish a comfort level with the technology long before being thrown into the discussion arena. Thus a comprehensive introductory package is vital before any activity takes place, perhaps including extensive pre-course activities. With this type of formula in place it should be possible for the students to concentrate on the message of the course material and not the delivery medium [Kaye 1989].

The Creation of a Learning Community

The clear advantage of CMC is the opportunity it provides for people to study independently and at a time and a place which suits them. However, the fear of social isolation, as identified above, is an ever present feature of CMC and other distance learning technologies [Ehrmann 1995]. It has been asserted previously [Kaye 1992] that these social shortcomings may even outstrip technical factors as barriers to the success of the class, with students encountering an educational experience for which they find themselves entirely unaccustomed. If students develop an attitude that they are isolated from the group it may only be a short step from there before the student is tempted to drop out of the course. Thus there is a fear that the inherently alien nature of the group dynamic will lead students to re-evaluate their involvement in the course.

While good facilitation and an easy to follow medium can help alleviate these problems, the primary responsibility here would appear to lie in the hands of the participants. Having opted for the independence of CMC study, it is hoped that the potential shortcomings of the medium will have figured in the students' assessment of whether or not to study by this method. That the more mature learner may adapt more readily to the collaborative learning style that CMC demands [Hansen and Gladfelter 1995; Gould et al. 1995], suggests its audience is limited, with an emphasis placed upon those for whom the tools required to learn in a student-centred environment (where the dominant actor is not the tutor or lecturer but the students themselves) is not a negative feature. There is certainly no reason to suggest that if the participants take their dual responsibilities (to themselves and to the group) seriously that the more thoughtful and reflective responses possible in a CMC environment should not produce a viable and inclusive community spirit [Newman 1990].

Unfortunately it may be an inevitable side effect of CMC that it will produce a residue of such problems and as a consequence the possibility of higher drop-out rates is something that will have to be factored in to the use of CMC as a delivery option. However, as mentioned above, the gradual spread of such technologies should ensure that people become ever more willing to accept the potential dislocation that may come as a result of electronic communications. As tele-working becomes more common and electronic media command an ever increasing percentage of all information exchanges, CMC as a forum for learning will appear less alien.

The Phenomenon of the 'Non-Active' Participant

This oxymoron is used to describe the CMC equivalent of the face-to-face tutorial student who turns up to classes, sits at the back and patently fails to become involved beyond the merely passive act of listening. These non-active participants, affectionately termed 'lurkers', are also a notable part of CMC based courses [Gould et al. 1995]. However, there is a major difference between the two: whereas participation in a tutorial is but one facet of the learning experience of a campus based student - part of an integrated package including lectures and ready access to tutors, this is altogether different from CMC students, for whom their only chance to actively engage in discourse about their subject comes within the computer discussion or via other impersonal communications such as by fax or telephone. Thus the phenomenon of lurking is an altogether more destructive element when found in such activities, with such failure to participate a clear danger to the cohesion of a group which depends to a much greater extent on the active participation of all those involved. With this sense of community partially dependent on the equitable participation of all those involved, an unwillingness on behalf of some members of the group to fulfil their responsibilities could seriously damage both their own and their colleagues learning experience.

This is especially relevant because CMC is widely accepted to break down the traditional barriers which exist to student participation in discussion [Saiedian 1993], such as: shyness, a lack of time to compose their thoughts, insecurity regarding the line of argument they wish to pursue and so on. That these barriers have no apparent place in CMC, only help to make this phenomenon even more galling for tutors and other participants.

There are several possible ways around the lurking phenomenon. Among the most obvious of these may be the decision to grade submissions, thereby forcing students to participate if they are to successfully complete the course. The need to have external verification of such grades is attainable via the archiving of submissions which most forms of CMC can provide. An alternative could be the use of 'learning contracts', where students agree to fulfil their responsibilities to the rest of the group, including full participation as and when required. Within a voluntary cohort such enticements or threats are largely irrelevant, although of those who volunteered for the Aberdeen seminar, all submitted at least one thoughtful response and several responded on multiple occasions. Whichever method is used, the necessity for active participation in CMC demands that such passive involvement be minimised through some mechanism.

The Role of the Facilitator

Many staff members fear the introduction of new teaching technologies. This is often based on an ignorance of the technology itself or, perhaps more often, a fear that the students' education will suffer as a consequence of the lack of direct contact. The former can be countered through staff development and training, although there may be an hostility towards the technology being employed and a subsequent lack of recognition for the necessity to train staff in these methods [Bates 1990]. The latter may only be dispelled as the use of such technology becomes more widespread and involvement proves there is no qualitative difference between CMC and traditional teaching [Hartley et al. 1994].

The undeniable truth regarding the use of CMC is that the role of staff involved in the provision of such options will and must be different from that which they play in a face-to-face environment. The facilitation of any online activity is a far different creature than tutoring in a traditional seminar environment [Davie 1989].

The level to which academics adapt to this alternative environment depends on the individual [Hansen and Gladfelter 1995] and their propensity to adapt their teaching style. While it was suggested above that technical requirements be rigidly set down to minimise differences, this inflexibility in the technology is the antithesis of the approach which should be adopted by a CMC facilitator, where in most cases maximum effectiveness will be achieved through a minimalist involvement, encouraging and prompting but not orchestrating. The facilitator's role is to develop the environment within which the student body can learn actively and interactively.

The 'learning community' identified above, is achievable as long as the students are engaged in a programme which encourages them to discuss the topic multi-laterally and as a group to tackle their problems and discuss the relevant issues. This is a new approach for those whose didactic background is more suited to the passive learning experienced in the more traditional delivery methods of conventional lectures and tutorials. While some may be reluctant to accept this, active learning is something that is increasingly identified as 'a critical variable in learning and cognitive development' [Harasim 1990]. Indeed, the notion of student-centred learning is something which would be beneficial if applied more broadly in traditional course delivery.

Conclusions

CMC would appear to be the ideal medium for truly 'open' distance learning. It provides a forum for the discussion of any issue which you care to study and if combined with other technologies, such as the World Wide Web and CD ROM can ensure that a remarkably broad learning experience is made available to students in their own homes. There is certainly no reason to suggest that the exposure to relevant information, meaningful discussion of the issues involved and academic support need be any less impressive than that which a traditional campus bound student experiences.

The issues highlighted in this paper can become problematic if left unaddressed, although they can just as easily be countered by a variety of means, including: thoughtful course design and structure; selective targeting of a student cohort willing to adapt to the environment; and perhaps most important of all, as a result of a programme of staff development designed to instil in the tutor the attitude required to perform well in an entirely novel teaching mode. While this latter may be one of the more difficult solutions to achieve, with distance education still considered by many a second class citizen. Luckily those who have become involved thus far tend to be those receptive to more progressive teaching methods. However, when this mode of delivery becomes more widespread (as would appear to be inevitable) some serious thought will have to be devoted to a re-skilling of tutors more used to traditional educational methods.

Perhaps inevitably CMC is forced to justify its existence and as a relatively new educational medium it is open to certain criticisms. However, the novelty of the medium does not necessarily make it inferior to traditional teaching methods and for many it can make all the difference between having the opportunity to study or not.

All innovative learning technologies are forced to satisfy existing pedagogic models and prove themselves capable of guaranteeing the quality of education which it is believed campus based teaching can provide. Yet to many involved in CMC, the very fact that they are under such pressure to ensure the pedagogic worth of their medium has ensured that their courses are better designed and more adept at forcing the students to learn actively than many traditionally delivered alternatives. The irony of the situation is that the thought and preparation required to produce effective CMC would surely be a benefit in many campus based courses.

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THE ACADIA ADVANTAGE ACADEMIC DEVELOPMENT CENTRE AND THE AUTOMATED COURSEWARE MANAGEMENT ENVIRONMENT

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Abstract: Phase I of the Acadia Advantage program in 1996, put IBM notebook computers in the hands of 375 first year students and 43 Faculty members to use in computer and technology-enhanced courses. An Academic Development Centre was created to assist faculty with the effective use of technology in and out of the classroom. The centre provides training sessions, brings in guest speakers and provides computer based solutions to academic needs. The Automated Courseware Management Environment (ACME) is a modular system that was developed to provide faculty with a way to create comprehensive web-based course pages without any knowledge of HyperText Markup Language (HTML). The ACME modules include a testing module (OTIS), a discussion group module, an upload-notes module and a course evaluation module.

Introduction

In September 1996, Acadia University began Phase I of the Acadia Advantage program. The program brought 375 first year students and 43 Faculty members to use IBM notebook computers in computer and technology-enhanced courses. Eight classrooms, ranging in size from 30 to 105 seats, were redesigned to include full multimedia teaching consoles for the instructor, and network and power connections at each student desk. The campus was completely rewired bringing fiber-optic cable to each building, and a high-speed network was put in place. All student residence rooms were wired for data, phone, and cable, and over 400 network hookups were installed throughout the Library, Support Center, and student common areas.

During the 1996-1997 academic year, the notebook computers were used as an integral part of first-year courses in Business Administration and Computer Science, along with selected courses in the Arts, and Sciences. In total there were 47 Acadia Advantage courses offered.

In September 1997, Phase II of the program will begin, and all first year students will be issued notebook computers. By the year 2000 all Acadia students will be a part of the program. All courses on campus will be able to make use of commercially available and Acadia developed software as well as the Internet and the Acadia Intranet. Students will use the notebook computers as tools with which to participate in class exercises, record and download notes, take online tests, and participate in out-of-class discussion groups, writing assignments, and online tutorial sessions.

The Sandbox

In May 1996, the Academic Development Centre, which became known as "the Sandbox", was created and given the mandate to assist Faculty with the effective use of technology in and out of the classroom. Three full-time consultants, along with 14 summer students, were hired to assist with courseware development, evaluate existing material, provide workshops and seminars, and work one-on-one with the 43 faculty in the Phase I program. During the 1996-1997 academic year, two of the full-time consultants and 8 of the part-time student staff remained to continue providing support, and to begin training of the 125 Phase II Faculty who received their notebook computers during September and October of 1996. Training sessions cover everything from the basics of Win95 to advanced CGI programming.

Courseware

It was clear from the inception of the Sandbox that the best way to make courseware material available to the students, both on and off campus, was to use the World Wide Web. After careful evaluation of several existing products which allowed schools to develop their course material for the WWW, it was clear that Acadia required a system with more flexibility, greater ease of use, and lower overhead in terms of ongoing support and management than was currently available.

The Automated Courseware Management Environment (ACME) was developed to meet the need amongst faculty and staff for a simple, intuitive, and efficient method of getting course information on the WWW, with the time constraint of bringing 47 courses online in a matter of a few months.

ACME is a modular system, which through the use of forms and cgi scripting allows faculty to create comprehensive web-based course pages without any knowledge of HyperText Markup Language (HTML). The primary aim of ACME was intended to be a tool for generating Course Homepages, however it also has several optional built-in modules such as an online testing system (OTIS), an online discussion group system (ODGS), a secure course-evaluation component and an uploading course notes option. Several other modules are in development. The remaining part of this paper will briefly discuss how ACME and its components work.

ACME

ACME is a collection of scripts, written in Perl, that provide a web-based environment designed to facilitate the presentation of course information. Faculty and students are identified through an authentication check, and are given varying privileges in the system depending upon their identity. After requesting that their courses be recognized by ACME, individual professors are provided with a personal profile that grants them course editing privileges. Utilizing a series of form templates the professors can then create and edit any number of aspects of their course, which are created as web pages "on the fly" by the scripts when a student comes into the course.

Although ACME is primarily designed to facilitate the creation and maintenance of these information-containing web pages, it has been extended, through modules also written in Perl, to provide extra functionality.

Making it work

Before they are able to view web pages created by ACME, users are first required to type in a name and password (which can be changed after the first login), and pass an authentication system supported directly by the web server itself. ACME's home page is stored in a directory with access controlled by this authentication system. It should be noted that ACME takes advantage of Perl's encryption capabilities to encode user's passwords so no plain-text passwords are ever visible.

Every user in ACME has what we refer to as a profile. Each profile is a text file that contains the user's full name, e-mail address, and login name. In addition, the profiles also contain an entry of all the courses that the user is registered in or has access to. This information is obtained through Acadia's Registrar. For faculty, there is an extra entry indicating that they have 'Instructor' access to the courses they teach, which allows them editing privileges.

Once a student user has entered the system, they can either go to a dynamically-generated list of all courses registered in ACME listed by year and discipline (Figure 1), or go to their profile page (Figure 2) generated by a cgi which lists all the courses in which they are enrolled.

The core functionality of ACME is the course editing area. From here, a professor can customize what information is available to the students and how the course is displayed. There are several 'themes' available such as Professor Information, Schedules, Related Texts, Teaching Assistants, and Curriculum which can be filled-in by the instructor and made available to their students. We have also designed a set of templates that allow a choice of colour/texture schemes, header/footer styles and layouts. Most importantly these templates (ie. the page layout) can be changed without having to re-enter the course information, and new design templates can be added at any time allowing a custom design that fits the instructors' taste.

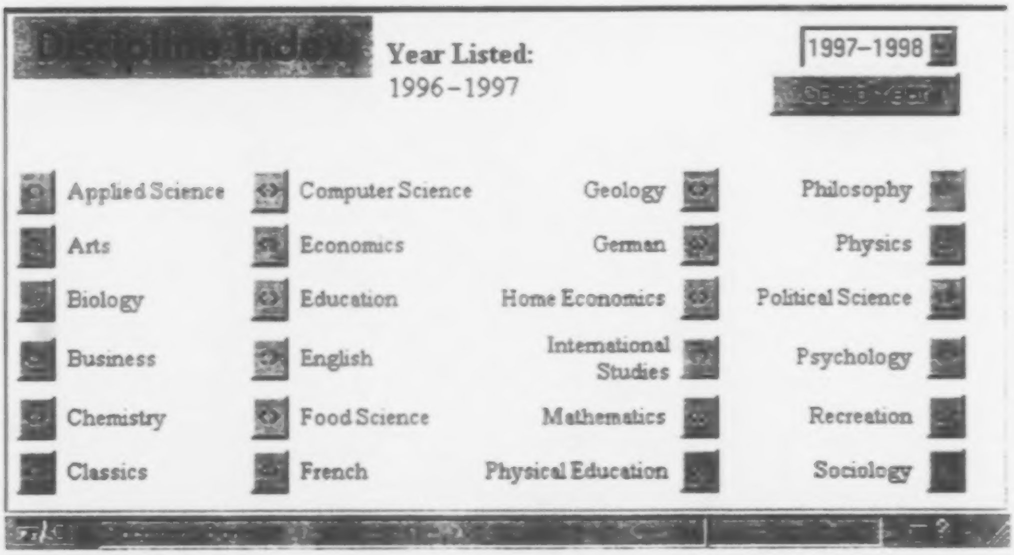
Discipline Index
Year Listed:
1996-1997
1997-1998
Go To Year
Applied Science
Arts
Biology
Business
Chemistry
Classics
Computer Science
Economics
Education
English
Food Science
French
Geology
German
Home Economics
International Studies
Mathematics
Physical Education
Philosophy
Physics
Political Science
Psychology
Recreation
Sociology

Figure1: Discipline index view in the Automated Courseware Management Environment.

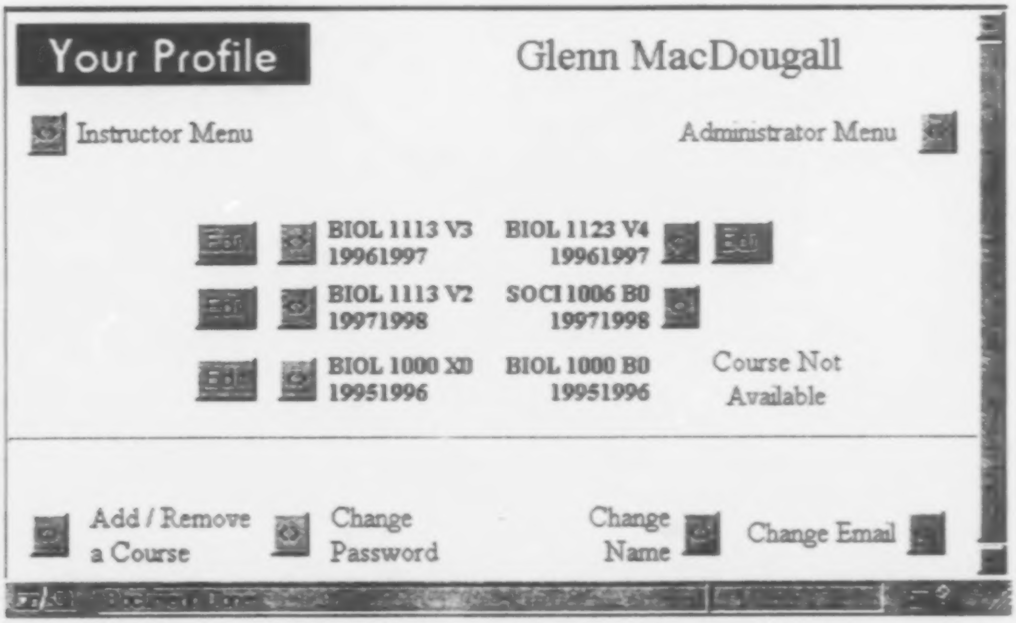
Your Profile
Glenn MacDougall
Instructor Menu
Administrator Menu
Edit
BIOL 1113 V3 19961997
BIOL 1123 V4 19961997
Edit
Edit
BIOL 1113 V2 19971998
SOCI 1006 B0 19971998
Edit
BIOL 1000 XD 19951996
BIOL 1000 B0 19951996
Course Not Available
Add / Remove a Course
Change Password
Change Name
Change Email

Figure2: Instructor profile view in Automated Courseware Management Environment.

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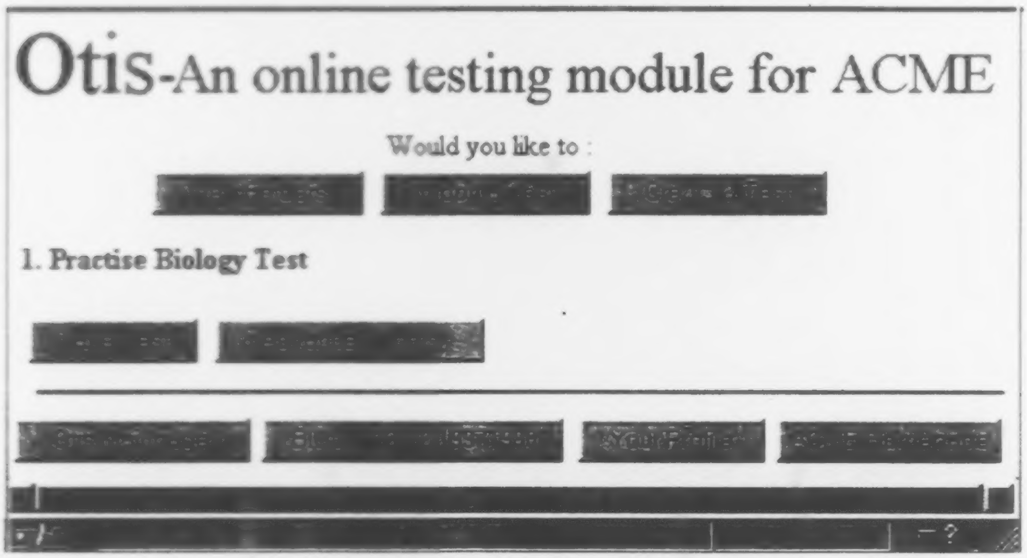
Module Plug-ins

Modules extend the functionality of ACME by building on and taking advantage of the system architecture that is already in place. Modules need only know which user and course is making use of them to be able to function properly. As they are an extension of ACME, this information is immediately available, making for a seamless integration of ACME and the modules. Currently there are four modules in place with several more planned. All are optional additions to the system, and the instructor controls the use of any one or all modules in a course.

Testing Module (OTIS)

The OTIS module provides online testing capabilities for any course in ACME. Instructors can create tests (Figure 3) using a series of templates that have enough flexibility to allow formatted text, images and, in the case of French tests, accents. The instructor can also perform advanced operations on the tests including editing, viewing student results, purging the results, moving the test to an archive, or making the test available to other courses.



Otis-An online testing module for ACME

Would you like to :

1. Practise Biology Test

Figure 3: Instructor view of the OTIS home page.

Tests are created in a three-step process. The first step is to tell the system the number of sections, after which the system presents the user with a set of options for each section. In the second step, the instructor would specify the number of questions that will appear in each section, and what type of questions each section will contain. Otis currently supports "fill in the blank", "multiple-choice", and "essay" questions. The final step of the test-creation is to actually enter the test data into a template created by the information input during the first two steps.

Templates have been designed to allow section titles, questions, multiple answers, and comments to be entered by the instructor. Questions can also be randomly displayed to the student from a larger set of entered questions. If the randomizing function is chosen, the instructor can input the number of questions to be displayed. All of this information is then stored in unique data files allowing the instructor to edit the test at a later date, simply by accessing the 'Edit Test' option.

Once the test is ready to be made available to students, it can be moved into one of the available archives in the course and viewable by the students. Students can then after proper authentication, call up the tests at their leisure, input their answers, and submit them for marking. With the exception of opinion questions, all of the

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questions will be automatically graded and the results displayed to the student utilizing frames and Javscript. At the discretion of the instructor the correct answers may also be displayed. If there have been comments entered corresponding to the answers that have been submitted, they will be displayed also. Also at the discretion of the instructor any previous tests may be made available to the students.

A record of the test submission is stored in a result file that the instructor can view at any time, and purge when necessary.

Discussion group module

This module was created to enable on-line threaded discussion groups for each course within the ACME system. Once a student enters the system, he or she can go to any course in which they are registered and enter one of that course's discussion groups. Within that group they can participate in any number of subtopics created by the Instructor. A student can both view and enter comments about the topic or post a reply to a comment that another student has written (a threaded response). Each discussion group provides the option of privately e-mailing the person that posted any message by clicking on their name, or to follow up directly in the public discussion area.

Rather than displaying a list of names and subject lines as in a standard newsgroup, the discussion group pages display the full text of all comments. The instructor of the course is given the ability to add and remove discussion groups and topics from the course, change group and topic information after creation, and remove entries from topics. Before any change is made to a discussion group the program first checks the user's profile to ensure that that they have been granted the rights to modify the group in question. If the user isn't properly authenticated or authorized, he or she will receive a warning message, and the administrator is notified of the action.

The system provides an easy-to-use graphical environment to facilitate collaborative learning. Some professors have organized their students into "teams" by providing groups on their system such as "Group One", "Group Two" etc. and having each group make comments only within a specific discussion.

Upload Notes

The Upload Notes module gives the instructor the file-by-file, directory-by-directory control they require for organizing files which they want to make available to their students. The file upload feature (a new feature of HTML) is used to query the instructor for the file they wish to make available. This file can be anywhere the instructor can access including their local hard drive, directories on their Intranet or the Internet. Once selected, the file is transferred to the Upload Notes system, which checks to see that the Instructor is not exceeding their space allocation, or that the type of the file uploaded is inappropriate. Most file types can be uploaded; however, inappropriate files can include a content type that is unknown to the server, or a cgi file that must be rejected for obvious security reasons.

The main view of Upload Notes shows a fully expanded directory tree with all files displayed as links. Students simply click on the file they wish to view.

Course evaluation module

This module is part of the ACME system but it is not within the control of the course instructors. The module appears in each student's user profile late in the term and becomes activated during the evaluation period. Once a user enters the evaluation system they are presented with the courses they can evaluate (if any). The student answers each question by selecting the appropriate response and entering any written comments at the bottom of the page. The results of each of the course evaluations are stored in three databases: one of which stores all of the textual information, another which stores the values for all of the courses evaluated, and the last storing the average "score" for each question. Additionally, as a course can only be evaluated once by each student, a database stores a list of the users and the courses they have evaluated. This information is used to insure a student does not evaluate a course twice.

At the end of the evaluation period the resulting databases are turned over to a designated individual that has sole access to the information. They have the ability to view and download the results, which then can be imported into any spreadsheet program.

Conclusion

When ACME was first presented to faculty, staff, and administration, response was wholeheartedly positive, and it has continued to be positive throughout the development of the system. For Acadia one of the greatest strengths of the ACME system is that it is a homegrown package. Over the past several months ACME has grown and improved through continuous evaluation by the programmers, and from the generous comments and suggestions made by Acadia faculty. The future of ACME has few limitations and it will continue to develop as a simple, convenient online environment for both Acadia students and faculty as new ideas and requirements come to the attention of the ACME development team.

An Environment for Multimedia Communication Literacy

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Abstract: The goal of this study is to characterise an environment for *multimedia communication literacy* (*MCL*), which is the next generation of the computer and network literacy. Starting with the definition of the *MCL*, we describe its importance of the experience of real-time multimedia communication. What is a suitable environment for the *MCL*? To investigate it, we made several experiments of distance learning by using ordinal lectures. In our experiments, we used a high-speed ATM (Asynchronous Transfer Mode) network with the Internet collaboration (video, audio and whiteboard combined), called the Mbone (Multicast Backbone) tools. We present measurements on the network traffic and the results of the questionnaires on distance learning to know its effectiveness. From these results, we discuss on the bandwidth required for distance learning and the requirements of the presentation tools. In conclusion, we suggest that the *MCL* is required in the future.

1 Introduction

High speed networking has introduced opportunities for new multimedia communication as video conferencing and VOD (video on demand) which will most likely use multicasting to transfer data across networks to several recipients. The first such applications have come into wide-spread use on the Internet, using the Mbone (Multicast Backbone), a virtual experiment network [Macedonia & Brutsm 94]. An example of the experiment is shown as [Banerjea et al. 94].

On the other hand, using the Internet presents some unique opportunities in the education because teaching/learning by the Internet is different from the traditional lectures or classrooms. It is one of the accelerators of computer and network literacy education. From the network technology as the above, the educational use changes in a multimedia communication environment. For example there is an approach like asynchronous or on-demand education [Harris & DiPaolo 96]. The other is interactive distance learning [Lee & Sullivan 96] [Sasse et al. 94].

Based on the background as the above, the different literacy education from the conventional one is required in real-time multimedia communication using high-speed networks. Computer and network literacy currently considered is not enough for it. The goal of this paper is to suggest the required literacy education and to investigate an effective environment for it.

First, we define *Multimedia Communication Literacy* (*MCL*) and describe its necessity and importance in Section 2. To consider an environment for *MCL*, in Section 3, we present the experimental environment

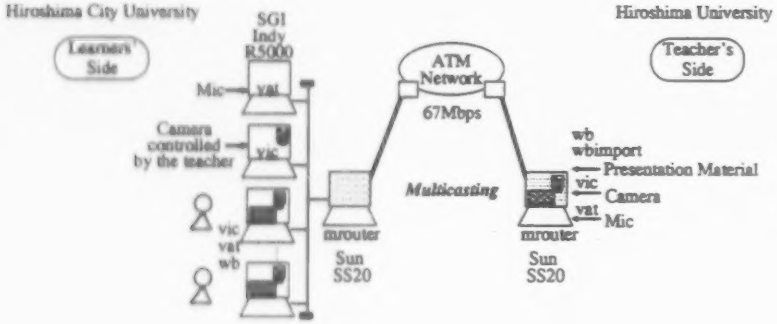

Figure 1: System Configuration (The Second Experiment)

using high-speed ATM network and the Internet collaboration (audio, video, and whiteboard combined) called the Mbone tools for distance learning. We present some measurements on the network traffic and the results of the questionnaires to the learners on effectiveness of the distance learning. As the results, we summarize an environment for distance learning. Finally, we conclude on the importance of the *MCL* and its effective environment and describe the future problems in the last section.

2 Multimedia Communication Literacy

Computer literacy is used as the concept to learn how to use computers and network literacy is to learn how to use the network services based on the Internet like E-mail and to search the suitable information through networks. Here we define the *Multimedia Communication Literacy* (*MCL*) as the literacy to operate interactive collaboration tools of video, audio and related things on the Internet for real-time multimedia communication. As new literacy using the Internet was naturally required by its emerging, the definition of *MCL* is natural in the next generation of computer and network literacy using high-speed networks and real-time multimedia communication. The *MCL* needs different factors from current network literacy because it requires interactive and real-time operations on a computer using the Internet.

Though interactive tools on the Internet are being developed, there is rare opportunities for students to use them. The *MCL* is significant to gain their experience in using them as usual communication methods not only for the distance learning but also for various occaisions in daily life. An environment using high-speed networks and multimedia communication is needed to learn the *MCL*. We discuss the effective environment in the next section.

3 Experiment Environment for Distance Learning

3.1 Outline of Experiments

The purpose of our experiments is to summary what network environment is needed, what kinds of tools are easy to use for teachers and learners for distance learning and to consider how effective this environment is for the *MCL*. The network between two sides of the teacher and the learners in the experiments is by the ATM backbone. The bandwidth, 67Mbps is available for this experiment. The system configuration in the third of our experiment is shown the [Fig. 1] for the example. We use the Internet collaboration tools (audio, video and whiteboard combined) and the mechanism of remote camera control. The following is the details of them.

Figure 2: The example of the screen dump image of the lecture

- Video: *vic* (Video Conference) [McCanne & Jacobson 95]
- Audio: *vat* (Visual Audio Tool) [Jacobson & McCanne 95]
- Presentation Tool: *wb* (White Board), *wbimport* [Jacobson & McCanne 93]

  Presentation pages of course material are displayed on a *wb* window. Before a lecture, all pages are cached into a raster memory by *wbimport*. A teacher can turn its pages, move a pointer on the page and write characters and figures for additional explanation in real-time. Also, *wb* can be used a shared board to write by both sides of the teacher and learners at the same time.
- Remote Camera Control: *Netscape + the UNIX scripts*

  A teacher can see moving pictures of any location of the learners' room by clicking the buttons on the special viewer of the Netscape with the embedded cgi-bin function using the UNIX scripts. He can control the remote camera to any direction (right/left and up/down) and zoom operation.

A teacher operates these tools on his own workstation (in short, WS) himself. The situation of learners side are different in three experiments as the following.

1st) There is only one WS for the collaboration tools in the learners' side. It receives data of moving pictures and voices from the teacher side through networks. Each learner can see the same images as that WS monitor on his individual monitor (19 inch) by a image transfer system. This system is the special equipment with functions to transfer video images of one specific WS to all other monitors in the same resolution as the specific one.

2nd) The number of WSs for the collaboration tools is the number of the learners. Different form other two experiments, each learner can operate all tools on his own WS with its camera and microphone himself. It is by multicasting.

3rd) There is only one WS to use the collaboration tools in the learners' side and learners see a wall screen (over 200 inch) projected of the monitor of that WS. The difference from the previous two cases is a shared big screen by all learners. We used a VICTOR ILA-M320S video projector (over 1000 TV lines and 2300 lumen) to project WS video images clearly.

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The detail of the experiment environment is shown in the [Tab. 1], and the [Fig. 2] shows the example of screen dump image in the teacher side. Learners see the similar windows on their own monitor or a big screen during a lecture.

	First	Second	Third
Learners (number of learners)	The first grade Faculty of Arts (45)	The third grade Faculty of Information Sciences (38)	(40)
Lecture Subject	The scheme of sending e-mails	The scheme of sending e-mails	On TCP/IP, especially network applications
Experience of computers and networks	2 months	2.5 years	
Visual Tool	vic		
Coding Format	H.261		
Bandwidth/Flame rate teacher ⟶ learners	510Kbps/8fps	400Kbps/10fps	512Kbps/10fps
learners ⟶ teacher	128Kbps/8fps		
Audio Tool	vat		
Coding format	PCM2	PCM	PCM2
Bandwidth	71Kbps	78Kbps	71Kbps
Presentation tool	wb/wbimport		
Remote camera control	Possible		
Multicasting	—	Use	—
Operation of tools by learners	Impossible	Possible	Impossible
Teacher's side machine	Sun SS20 (75MHz x 2, 128MB)		
OS	Solaris 2.5		
Learners' side machine	Sun SS20 (75MHz, 96MB)	Indy R5000 x 50 (150MHz, 64MB)	Indy R5000 (150MHz, 128MB)
OS	Solaris2.5	IRIX 5.3	IRIX 5.3
		Sun SS20 (75MHz, 96MB) Solaris2.5	

Table 1: The Detail of Experiment Environment

3.2 Results

In the environment as the above, the maximum bandwidth during the lecture is 600 Kbps from the [Fig. 3]. The learners' impression on images (both moving pictures and presentation pages) and voices is that there was no problem for an ordinal lecture from the result of the questionnaires as the [Fig. 4], of which the total number of answers is 123 through three times. The question items 4 and 14 in the third were omitted because the learners are the same in the second. The vertical axis of the [Fig. 4] means normalized average of each questionnaire item. To obtain each average, answer items of a question are weighted from 1 to the number of its answer items. Higher value of an answer item means the better result of the experiment environment for distance learning.

3.3 Discussion

Though emphasis of a high-speed network is the current tendency for distance learning, the bandwidth, 600 Kbps, gives the same quality of ordinal lectures in the case that course material can be prepared in on-line presentation style like our experiments in advance. The importance is ensured bandwidth about 600Kbps for distance learning.

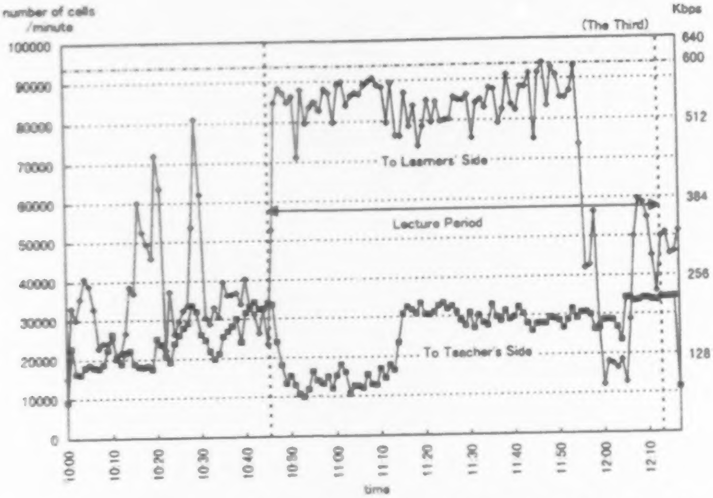

Figure 3: The number of Cells of Transferred Data (The Third Experiment)

Also the result is obtained that distance learning itself was very attractive and effective for the learners. This style of distance learning is effective for reinforcing attentions and understanding of subjects on the network, computers and related things from their free descriptions in the questionnaires, even though they did not operate the tools themselves positively.

Focus on the difference of styles on displaying images and hearing voices, that is, the difference between an individual monitor with a speaker and a microphone and a shared big screen with a speaker and a shared microphone. there is no obvious tendency preferring one of two styles from the questionnaire results. In either case, the brightness and clearness are enough through these experiments. It is important for distance learning to care these points. In spite of the audio and visual styles, a on-line presentation tool is the key point for distance learning. Its necessities are to display course material clearly and the pointing and writing functions by both sides of the teacher and learners. *Wb* is the effective tool displaying PostScript images. We obtained its effectiveness from the learners as [Fig. 4]. However, it is hard to display synchronously with turning pages because of the over load to process the PostScript images. The cache in a raster memory is needed before a lecture. So we should improve functions such as capture of raster images, dynamic capture of any other windows and input method of various language code.

4 Conclusion

Concluding this paper, we first suggest that the *MCL* is required as the next literacy for high-speed networks and the real-time multimedia communication in the future. Next, we show the concrete environment for the *MCL* by the experiments of distance learning to investigate a good environment for the *MCL*.

If the *MCL* is usual as literacy education, it will be natural and easy for the people living in the next generation of a cyberspace to use multimedia communication method in the future. As future works, we should consider the training of teachers for the *MCL*.

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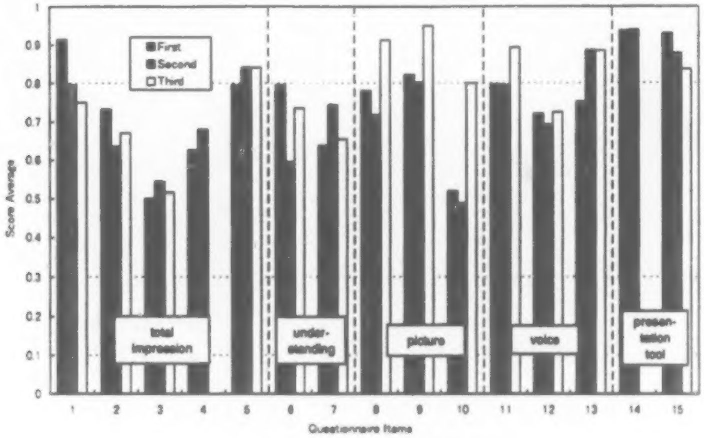

Major Questionnaire Items

1. Stimulate Interest in class
2. Strain compared to an ordinal class
3. Easiness to ask question
4. Effective experience to learn on networks
5. Familiarity of this style of class
6. Difficulty of the lecture content
7. Understanding level of the lecture content
8. Smoothness of moving pictures
9. Distinction of moving pictures
10. Clearness compared to TV or VIDEO images
11. Time lag between voices and moving pictures
12. Communication delay of in questions
13. Clearness of voices
14. Easiness of the presentation tool
15. Usefulness of the presentation tool

Figure 4: Results of questionnaires

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Acknowledgments

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Customization of Educational Material Delivered over the Internet

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Abstract: This work suggests WWW server of a special architecture which improves customization of educational material delivered over the Internet to end user. Here we also describe so-called Distributed Learning Environment. Server that we suggest deals with so-called Virtual Multimedia Documents (VMD) dinamically in order to avoid difficulties while dealing with HTML documents, because HTML uses different tags for different types of media objects. Structuring of hypermedia database and its elements is also described in this article.

1. Introduction

Generally, World Wide Web (WWW) rests on three fundamental concepts:

- HTTP (HyperText Transferee Protocol);
- the URL (Uniform Resource Locator) addressing/naming scheme;
- HTML (HyperText Mark Up Language).

HTML serves as the de facto standard for structuring, storing and exchanging WWW documents. HTML provides a solid background permitting different vendors to develop a variety of browsers running on different hardware and software platforms, but displaying data in approximately the same way [Nielsen 1990].

Originally, HTML aims to provides two primary capabilities: - so-called Mark Up facilities for describing how textual information should be represented or displayed. - a mechanism for including within a document links or references to other documents; thus, when a user "selects" a link, the document associated with that link is accessed.

However, the consistency provided by HTML comes at a cost: it is currently very limited in its data formatting [Nielsen 1990], multimedia and interactive capabilities, far more so than what most users need to create a modern educational applications (i.e. courseware).

All recent HTML developments can be seen as attempts to overcome the above mentioned problems, currently, HTML allows a document to include other forms of media objects, such as external files interpreted by so-called Helper application or by Plug-In applications, Java applets, Java scripts etc.

Unfortunately, these recent enhancements of the WWW concepts contradict to a basic idea of platform independence which made HTML the de facto standard. In other words, HTML documents are loosing compatibility due to embedding different media. Thus, a Java capable browser is needed to view Java applets or scripts, special Helper applications should be installed to provide access to interactive courseware modules, etc.

It is widely recognized now that a special customization mechanism is needed to disseminate courseware materials to a big number of users having different software and hardware installations.
In this context, we develop a so-called Distributed Learning Environment which is a WWW server providing, among other capabilities, a dynamic customization of educational materials to a particular user profile [Maurer et al. 1994].

2. Architecture of the Distributed Learning Environment

The system operates with so-called *Virtual Multimedia Documents* (VMD) [Maurer et al. 1995]. A VMD is a semantic unit integrating a number of media objects such as text, picture, sound, video, animation, or simulation. Actually, any types of media objects can be combined into a VMD.

Each multimedia document has an actual contents and a logical structure. Both are defined by the author of a document and are represented in a special data structure kept on a server site. The data structure is described in more detail in the next section.

Informally speaking, VMD is a number of so-called clusters which are interrelated much in the same way as alternative media objects might be embedded into an HTML document. In a simplest case, a VMD can consist of a textual document with an embedded cluster. Each cluster contain a number of alternative media objects one of which is dynamically selected when the VMD is presented to a client [Maurer et al. 1994].

Thus, we can say that when a VMD is presented to a client, a context of use is superimposed on its contents and structure to affect the presentation. This effect is produced dynamically by the server by means of presentation mappings and depends on the chosen navigation path, user profile, or technical circumstances.

For instance, a particular document or individual media object may participate in different hyperlink structures and, hence, be displayed using different sets of anchors, i.e., active elements which provide a possibility to jump to other media objects.

It may also be the case that the same contents must be presented in different languages or that a certain media type must be mapped into another type because the former cannot be visualized by a particular hardware/software installation (e.g. animation to a still image) or perceived by a particular user (e.g. text to speech, large print, or Braille mappings supporting visually impaired users).

Depending on the desired type of re-use of a document it may also become necessary to present copyright information on different levels of granularity. Server generates resultant document presentations for clients using the following information:

- logical structure showing the contexts in which a document participates (for instance, a document, which is stored once on a server, may be visualized differently when being re-used within two different CAI courses);
- user profile capturing special parameters defined by a user, such as language, software and hardware preferences or media type preferences (e.g. if the user is disabled, the type of some media objects should be replaced with another type);
- client and connection profile determined by technical parameters at the client site or communication related parameters such as help-applications and plug-ins availability, Java applets capability, transmission speed, quality of service or quality of delivery resulting, e.g., in variation of image

resolution, presentation size, color depth or replacement of continuous video sequences by still images.

3. Structuring a Hypermedia Database

An essential property of hypermedia is a non-linear chaining of different types of multimedia documents. More precisely, hypermedia deal with data structures imposed on a top of a collection of multimedia documents. Thus, hypermedia can be maintained in a special type of databases. A hypermedia database is not simply a bucket full of multimedia documents but is structured and also large in terms of number of components and storage size.

The data model we propose, supports the following structuring elements:

- collection
- cluster
- virtual multimedia document.

Collections can be built from other collections or from virtual multimedia documents. Collections are associated with particular navigational mechanisms explained below.

Clusters represent families of media objects of related contents. They allow an author to combine alternative representations of a particular piece of information, e.g., a piece of text in different languages, their spoken versions, and a screen-reader compatible version. Upon client access one document out of a cluster is selected by the server depending on context information as discussed earlier. Media Objects are the smallest units of contents representation. They are further combined into clusters and virtual multimedia documents. The following points relate these terms to the role and functionality of the hypermedia database.

Virtual multimedia documents are stored in a special internal format. Each multimedia documents has its unique logical structure which is defined as references to embedded clusters (see Fig. 1).

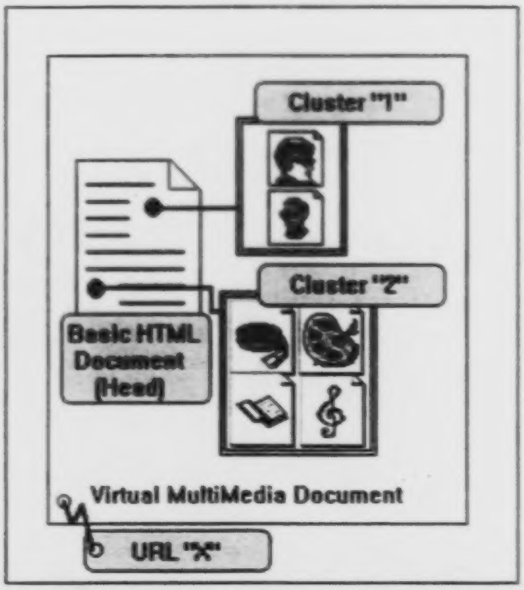

Fig. 1: Internal Structure of a Virtual Multimedia Document

This structure is determined by the author of a document and cannot be altered by a server. Clusters can be seen as containers for alternative media objects which can be added/modified independently. Thus,

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the virtual multimedia document is a template which is filled with actual content (i.e. with media objects) in due course.

When a media object is stored into a hypermedia database, it is inserted into one or more clusters and is provided with a number of attributes which are determined by the author. Thus, a number of related media objects is combined into a cluster to provide a possibility for the server to automatically select one member of such cluster to serve the special profile of a particular user. For example, a document written in a particular language is automatically selected relying the client's language preference. Similarly, a special viewer for visually disabled users may always set the user preference causing the server to select a speech or text fragment instead of any other media.

When a virtual MM document is stored into a hypermedia database, it is included into one or more collections. Collections impose an additional navigational structure on multimedia documents participating in a collection. For example, a collection can be scanned in a forward or a backward direction or a member can be selected through a pop-up menu [Maurer and Scherbakov 1996].

4. Authoring and Visualisation of Virtual Multimedia Documents

Virtual multimedia documents are authored much in the same way as ordinary HTML documents. The only difference is that all references are made as special non-HTML tags. The tags refer to clusters in an unified way. The term 'in an unified' way is very important in this context since the HTML supports different tags to embed different media objects including a necessity to provide some very technical details on such embedded files (say, position of an applet, size of a window to be used, etc.). In our case, authors simply refer to a cluster by its unique name.

A typical example would be a virtual multimedia document having a reference to a cluster 'Figure X' tagged as:

<! Refer Cluster 'Figure X'> See Fig. X</Refer>

Note that only one of such cluster members is dynamically selected when the VMD is presented to a client. The system uses special information on a particular user (a so-called user's profile) and selects a media object which is most suitable for visualisation on the particular WWW client (see Fig.2).

The cluster 'Figure X' may contain a still image 'FigX.gif', Java Applet 'FigX.class', an external file 'FigX.hmw' and some other media objects as members.

When the document is presented to a client, the non-HTML tag is dynamically replaced by one of the following HTML tags:

- <IMG SRC="FigX.gif"> if the client is not Java capable and does not have a Helper-application or Plug-In to deal with '.hmw' files
- <EMBED SRC="FigX.hmw" WIDTH=80 HEIGHT=60> if the client has a Plug-In to deal with '.hmw' files
- <A HREF="FigX.hmw"> if the client has a Helper application to deal with '.hmw' files
- <APPLET CODEBASE="..." code=FigX.class WIDTH=80 HEIGHT=60> if the client is Java capable and does not have a Helper-application or Plug-In to deal with '.hmw' files

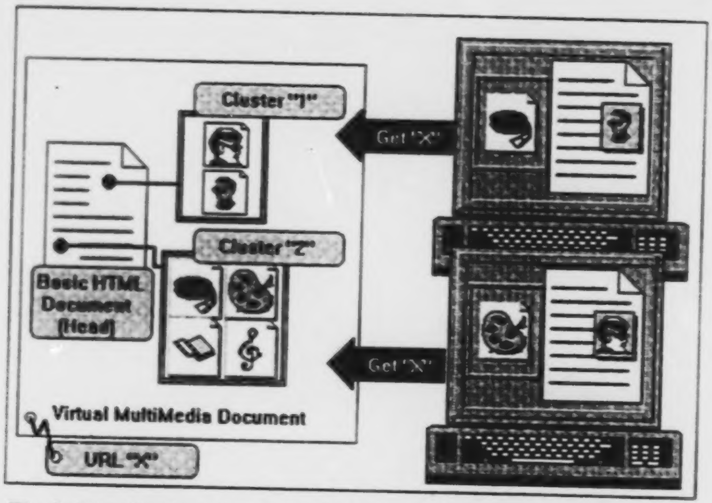
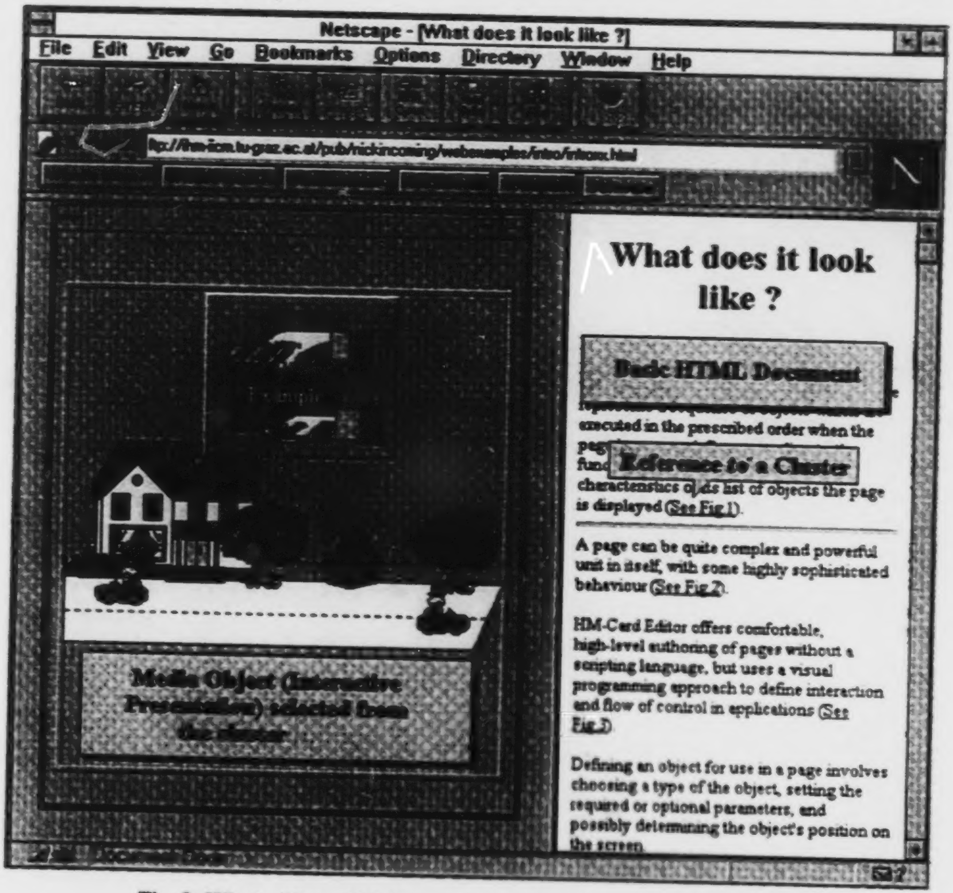

Cluster "1"
Get "X"
Cluster "2"
Basic HTML Document (Head)
Get "X"
Virtual MultiMedia Document
URL "X"

Fig. 2: Visualisation (Customisation) of a Virtual Multimedia Document

This replacement is made dynamically by the server and it depends on the user profile which is set for each registered user (See Fig 3.)


Netscape - [What does it look like ?]
File Edit View Go Bookmarks Options Directory Window Help
Basic HTML Document
Reference to a Cluster
Media Object (Interactive Presentation) selected from the cluster
Document: Done

What does it look like ?

executed in the prescribed order when the pag fun characteristics of its list of objects the page is displayed (See Fig 1).

A page can be quite complex and powerful unit in itself, with some highly sophisticated behaviour (See Fig 2).

HM-Card Editor offers comfortable, high-level authoring of pages without a scripting language, but uses a visual programming approach to define interaction and flow of control in applications (See Fig 3).

Defining an object for use in a page involves choosing a type of the object, setting the required or optional parameters, and possibly determining the object's position on the screen.

Fig. 3: What a Virtual Multimedia Document looks like on a client site

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5. Conclusion

As can be seen, the new media capabilities which are currently introduced into WWW technology are not so useful as they could be. In general case, embedding such advanced media objects into HTML documents makes them dependent on a particular hardware and software platform. We believe that a special customization mechanism would eliminate the problems caused by the fact that HTML documents have 'media specific' tags embedded in them. This customization mechanism could be accomplished by dynamic mapping the rich structure of so-called virtual multimedia documents onto the simple HTML tags using a particular user's profile to select media objects for presentation.

A number of courseware examples built upon the described principles are available from: *http://www.iicm.edu/courseware*

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Interactive Hypertext Documentation for Computer Based Applications

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Abstract: Computer based teaching (CBT) presentations are large and complex software systems that need extensive and thorough documentation in order to make their development and maintenance possible. There are many well-known methods used to document programming systems. A CBT, however, is unique in that its environment is typically distributed, and consists of many properties and objects that are stored all over the application. Therefore, it requires a different method of documentation that has specific features to keep track of the system's development.

This paper describes the design and implementation of ***"XDoc"***; a documentation system for ToolBook's authoring environment. XDoc supports interactive access to both the ToolBook application and its documentation. It can be used either to create documentation on-line, or off-line (that is for existing applications). Xdoc also solves the typical problem of inconsistency between an application and its documentation by using hypertext links.

1. Introduction

Documentation plays a major role in the task of developing and maintaining software systems and Software Engineering provides various methods to help create documentation, [see Gehani et al. 91]. CBT presentations are not only large and complex software systems; they are also particularly likely to be modified because of various demands coming from different learners.

This paper presents an attempt to build a documentation system for a specific authoring environment: ToolBook, produced by Asymetrix; [see Toolbook 94].

ToolBook is a popular object-oriented development environment that provides a graphical user interface for creating objects, and a full-featured programming language, called OpenScript, for programming objects behavior. Programs that are associated with the objects are called "scripts". Often, a developer of a ToolBook book pays too much attention to documenting the underlying scripts, and neglects the significance of these objects. This is just one of the reasons why many ToolBook applications have ambiguous and incomplete documentation which, in turn, creates serious problems during the maintenance of the application.

This paper describes the design and implementation of an interactive documentation system, called XDoc, that supports a documentation of ToolBook applications. It promotes what we call *"on the fly" documentation* or *"on-line" documentation*, which means documenting *during* the actual development of a system. XDoc ensures that the consistency of data and information between the system and its documentation is maintained all the time, and also enables the developer to simply update the data in the documentation book by just a click of a button.

When a ToolBook developer wants to start a book and document it, he or she uses XDoc, which generates two books. These books are created from two different templates; one for the ToolBook developer to work on, named *IDB* or Interactive Documenting Book. The other book serves as the IDB's documentation book, named '*NeatDoc*'. In what follows, we will use the term 'IDB' for any user book created with XDoc, and 'NeatDoc' for a documentation book. An IDB and its NeatDoc interact with each other throughout the implementation processes of the IDB.

XDoc also allows documentation of an existing work; that is *off-line documentation*. However, this paper focuses on *on-line documentation* to further emphasize the importance of this concept in ToolBook documentation.

This paper is organized as follows: Section 2 gives a brief history of projects leading to XDoc; Section 3 is an overview of the documentation of ToolBook applications; Section 4 is a major section describing XDoc in greater detail; and Section 5 gives a case study on using XDoc for an on-line documentation of a ToolBook application.

The development of XDoc did not result in a finished product, but rather emphasis was put on the creation of a new methodology. With future work, XDoc may turn into a more complete documentation system for ToolBook books.

2. History

Our work is based on an integrated authoring environment in ToolBook, called, NEAT - *iNtegrated Environment for Authoring in ToolBook*, designed by T. Müldner, Acadia University; and S. Mayer and C. Unger from Hagen University, Germany as described in [Müldner 93a, 93b, Mayer et al. 93, Müldner 94. Müldner et al. 96]. NEAT, version 3.0 provides a template and various facilities for rapid prototyping and use of computer-based presentations called *neatware* [see van Veen 95].

The next version of NEAT, called XNeat 4.0 gave rise to XDoc. XNeat allows users to manipulate a repository of neatware and backgrounds that are created with ToolBook (for more details, see [Mahayuddin 96]).

3. ToolBook Documentation

Behind every ToolBook application there are its *object hierarchy* and its *event-driven* behavior (for more details, [see Toolbook 94]. As difficult as it is to visualize these concepts, it is even more difficult for ToolBook developers to document them in their applications; even for those who are experienced with ToolBook. This is perhaps one of the reasons why object documentation is not given much attention by programmers during the development of a ToolBook application.

Novice ToolBook programmers often have trouble finding the location of scripts since most of the visible objects they encounter do not have any script in them; experienced ToolBook developers usually put their scripts in objects of higher hierarchy, which are invisible and *incomprehensible* to novices, e.g., in a background or in a system book. Unfortunately, most of the time the location of these scripts is not documented.

Other than system variables and arrays, it is not compulsory for a ToolBook developer to formally declare the names of variables, properties, or handlers. This is an "advantage" favored by developers; particularly because most programmers find it irrelevant to declare local variables as they are only active within a handler. But, if a ToolBook developer decides not to use any system variables or arrays, what *is* there to be declared? How does a person who is trying to examine a piece of OpenScript code distinguishes a local variable from a user property, or an OpenScript keyword from a function call, if there is no way to differentiate them (unless, the programmer scans through it in the ToolBook debugger)?

Classical recommendations, adapted from documentation methods of non object-oriented programming languages, include the following:

- a head section (in comments) on top of every script of an object describing important data such as the functionality of each handlers, modifications made, and date when script was last modified;:
- consistent prefixes on the names of variables, properties and handler; for example 'sv' for system variables, such as svNumOfUnits, svUserName;
- clear comments for complicated and ambiguous pieces of source code in OpenScript.

In general, documentation that is separated from its application is usually stored in a text file that is organized in a linear way. This method is inadequate since maintainers and developers are always interested in viewing the corresponding source code at the same time as viewing its documentation as described in [Sametinger 91].

The use of hypertext solves the problem mentioned above. Hypertext makes information retrieval easier by enabling "nonsequential writing and reading". It consists of *nodes* which link or bridge the user to more relevant information by just selecting it. The information may be in the form of text, a picture, or even a video sequence [see Sametinger 91 and Instone 95].

Short4OpenScript is the only tool for ToolBook documentation, besides XDoc, that the authors have found thus far. It has been created recently by Carsten Blau, [see Blau 96], of the *Institut fuer Mediengestaltung und Medientechnologie* in Mainz, Germany and is yet to be fully developed (at the time this paper was written). Short4OpenScript creates documentation out of an OpenScript by keeping the documentation in a separate text file, and then generating an HTML-document from it.

4. XDoc

The name XDoc is actually a combination of two acronyms; **X**Neat 4.0 -- the name of the original version of XDoc, and **Doc**umentation. XDoc supports three types of users: ToolBook *developers*, who want interactive and accurate documentation for their applications; ToolBook *maintainers*, who maintain the ToolBook applications; and also *other system developers* who are perhaps interested in how the ToolBook applications were implemented.

By promoting *"on the fly" documentation*, that is documenting *during* the development of an application, XDoc maintains the consistency of data and information between a ToolBook application, and its documentation. It provides interactive access to both the IDB and its NeatDoc, hence minimizing the developer's documentation efforts.

XDoc consists of three different environments: the *XDoc Panel* environment, the *IDB* environment, and the *NeatDoc* environment. The IDB (Interactive Documenting Book) is where the *ToolBook developer* creates a new application, whilst the NeatDoc is the IDB's corresponding documentation book.

XDoc maintains a repository of IDBs and provides tools to manipulate them in the XDoc Panel, such as creating a backup for an IDB and also opening an IDB (which in turn opens its corresponding NeatDoc). In addition, it allows the user to choose which IDB to add to or to remove from the repository. This particular repository is useful for the developers to keep track of all the IDBs that they created; or those that are created by others, but made accessible to the developers. The Panel also provides tools to manipulate a repository of backgrounds, or *page templates*, mainly to be used by NeatDocs.

Developing an application out of an IDB is very much similar to developing any typical ToolBook application except that the user is given the option to document the objects created. When the developer decides to document an object, XDoc will get its name from the user, and then automatically record the necessary data in the appropriate page of the IDB's NeatDoc. The user can then either proceed to work in the IDB, or instead go to the NeatDoc to elaborate on the documentation of the object.

If the user creates a new background or a new page in the IDB, XDoc will request to create new documentation pages in its corresponding NeatDoc. For example, after creating a new background in an IDB, the user is required to create a documentation page in NeatDoc using the "Pages on a Background" template. This is because the NeatDoc will keep track of all the pages that share this background in the IDB. In addition to that, the user can also add a documentation page of type "Scripts" if it is desired that NeatDoc keep track of the script of this new background.

A NeatDoc is the documentation book for an IDB. It records everything in the IDB that the developer wants to document accurately, and it gives ample space for the user to put comments on. At the same time, it also keeps track of some of the details in the IDB which the developer did *not* choose explicitly to document. For example, a NeatDoc records the total number of backgrounds that are in the IDB, even if the developer chose to document only *some* of those backgrounds.

A NeatDoc makes the documentation tasks easier by providing various tools for the developer. For example, there is a tool to obtain the name and ID of a background in an IDB, and also a tool to create a link to the properties of an object in an IDB.

Besides recording the most current information on an IDB, a NeatDoc is also able to take note of any "old" information of the IDB. For example, if the developer had deleted an object from the IDB, perhaps because of some error, the NeatDoc does not erase the documentation of this object. Instead, it puts a side note in the documentation saying that this object has been deleted. The developer can then comment on these errors in the built-in 'Comment field' in NeatDoc. This feature is particularly useful during maintenance, or even during development because the users will be able to see more the errors made, and hopefully not repeat them.

Pages in a NeatDoc are called 'documentation pages'. Both the backgrounds and the pages have specific functionality needed for documentation; and are developed to interact with the objects in an IDB. The developer can choose the appropriate "page template" according to the portion of IDB that he or she wants to document in a documentation page. These portions are: a certain part of the book itself; a certain part of a background in the IDB; or a certain part of a page in the IDB. These parts in turn consist of things such as the user properties, the underlying scripts, the objects on a page or on a background, and many more.

Each NeatDoc environment provides the user with easy navigation and browsing capabilities similar to neatware ([see Müldner 94]). It has both the 'Control Panel', i.e., the tool for *building* the *contents* of the NeatDoc; and also the 'Table of Contents Browser', i.e., the tool for *navigating* through the *contents*. The use of hypertext in a NeatDoc enhances these capabilities further by letting the user view the data of its corresponding IDB directly from the NeatDoc.

5. Case Study - The Working System

This section provides a case study in XDoc. Space limitation prohibits detailed description of all interesting operations; instead only several important ones are demonstrated.

The first operation to be demonstrated is the creation of a new IDB. In the XDoc Panel, we first select the 'Create New' option under the menu heading 'IDB'. A dialog will pop up, providing a field to put in a name for the *new* IDB (say, "Appl" -- for "Application 1"). We will also be prompted for the names of the first background and the first page of the new IDB. (Let's call the first background "A1", and the first page "B1".) When this information is entered, we can actually see XDoc creating a new IDB using the 'IDB template'. Soon afterwards, a NeatDoc for the IDB is also created by using a 'NeatDoc template'. Specific initializations are then performed in order to make this NeatDoc collaborate with the new IDB. The new IDB, "Appl", is similar to any new ToolBook application, and is accessible to all the tools in ToolBook. The only difference between this book and any other standard ToolBook book is that the names for the IDB's first page and for its first background are already provided, and that this book also has built-in capabilities to interact with a NeatDoc, i.e., its own documentation book. Figure 1 shows the front cover page of the NeatDoc that documents IDB "Appl". Here, the NeatDoc's "Table of Contents Browser" has been opened to give the reader an idea of the kind of documentation pages that have already been set up upon creation of both the IDB and the NeatDoc.

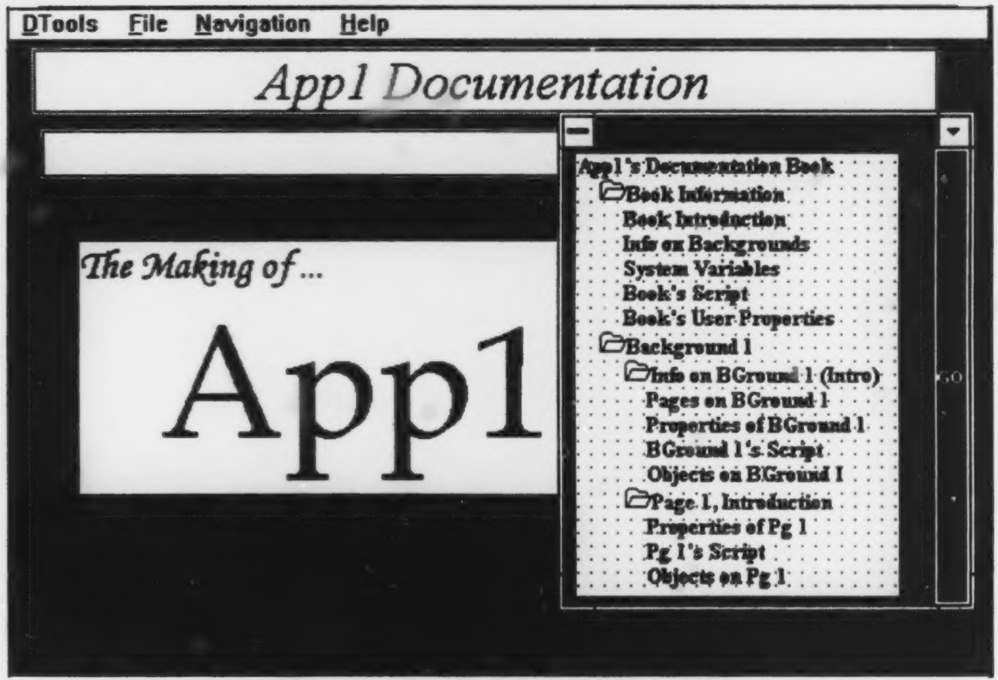
DTools File Navigation Help
App1 Documentation
The Making of...
App1
App1's Documentation Book
Book Information
Book Introduction
Info on Backgrounds
System Variables
Book's Script
Book's User Properties
Background 1
Info on BGround 1 (Intro)
Pages on BGround 1
Properties of BGround 1
BGround 1's Script
Objects on BGround 1
Page 1, Introduction
Properties of Pg 1
Pg 1's Script
Objects on Pg 1

Figure 1 A New NeatDoc created for an IDB

Next, we create new system variables for "App1". Two system variables were created: sv_UserCount, for the purpose of counting the number of people who use IDB "App1"; and sv_UserNames, to record the names of these users. Once the variables are created in "App1", we can move to its NeatDoc, and click on the 'Update Page' button that is available in the 'System Variables' documentation page.

If a system variable; for example 'sv_UserNames' has a value that could not fit in the one-line field provided in the NeatDoc's page then, we can double-click on a line where this value is located, and a 'View Box' will pop up displaying the full contents.

We proceed through this case study by discussing the documentation of graphical objects. Specifically, we will create a few objects on background "A1", i.e., the first background in "App1", to *greet* a user when he or she enters the IDB. First, a rectangle is created for decorative purposes; and therefore is not documented. A text field, named "Welcome", is then added to welcome the users.

Now, we will add a new button, named "GreetingButton" to the background and then put a script in it, so that the user can get a greeting of "Hello World!" when he or she clicks it. We also want to create a link from the IDB to the script of this button. To do so, we can use the menu option "Create Script Link" to create a hypertext link to the underlying script of the button in the IDB.

6. Summary and Future Work

ToolBook developers have had difficulties in finding a documentation method that matches their needs in developing an application. XDoc was implemented with the intention of supplying a tool to assist these developers. It allows them to document their applications on-line, in a standard and an easy way. XDoc minimizes developer's documentation efforts by providing an interactive access to both the application book and its documentation book. In addition, the use of hypertext links promotes data consistency between the two books.

Much more work could be done to further enhance XDoc's capabilities. Below, we describe some suggestions for future implementation. Documentation operations of XDoc, in its current form, are not fully automatic even though both the IDB and NeatDoc *are* interactive. With a considerable amount of work, new

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and appropriate documentation pages in NeatDoc could be created as soon as they are needed by an IDB. A link from each of these pages to the appropriate object in IDB could also be assigned at the same time. NeatDoc pages of type "Pages on a Background" currently do not keep track of a deleted page. Similarly, pages of type "Backgrounds in a Book" do not keep track of a deleted background. A deleted page or background has to be documented manually by the developer. These problems can be easily fixed by adapting the implementation used in pages of type "Objects", "System Variables" and "User Properties", i.e., by using an array to hold the information about these pages or backgrounds, and update it when necessary. For the NeatDoc pages of type "Scripts", it would be useful to add the capability to scroll automatically to a specific portion of code, before it is displayed in a 'Script Box' for viewing. This can be easily implemented by providing a tool to create hypertext links in the 'Comments' field. A user would first select a few words from the comment field, and then activate this tool, which would then ask the user which portion of the script a 'Script Box' should scroll to. By incorporating this information with a "ready made" script, the words selected can then be made a hypertext to link and scroll to the specific portion of the script. A developer's documentation efforts could be further reduced if all the tools that a NeatDoc provides were available on a 'toolbar', or a 'palette' instead of using menus. This feature would be easy to implement. Finally, since both an IDB and its NeatDoc depend on each other for having consistent data, future implementation that enhances the security for these two books would be desired. For example, XDoc could prompt the user to save both books when he or she chooses to close only one of them.

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HERE'S LOOKING AT YOU: VIDEO CONFERENCING, COMPUTERS AND ILLNESS. ANTHONELLA'S STORY.

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Abstract: This paper describes an innovative project between the Australian Centre for Computer Enhanced Learning, IBM Australia Ltd. and the Royal Children's Hospital School, Melbourne, Australia. Described are two case studies of children involved in the project, with a summary of the impact new and emerging technologies have on children in exceptional circumstances.

The initial aim of the project was to make communication and contact between hospitalised and homebound children, and their peers, as normal as possible. The use of multimedia, Internet, the World Wide Web, and video conferencing, were seen as valuable ways of achieving that aim.

INTRODUCTION

The emergence of Multimedia Computing that enables the integration of video images, sound, graphics and text has changed the way young people learn things. In Multimedia computing users control the computer presentation by controlling the rate and selection of media being presented. In addition to providing interaction to the user, multimedia provides opportunities for users to make their own choices and direct their own experiences. Though there is no conclusive research evidence, several studies have indicated that multimedia improves student learning and teacher presentations [Toomey, Mahon & Thalathoti 1993; Toomey, Mahon & Thalathoti 1994; Kozma 1994].

Widespread new application areas of Multimedia computing include video conferencing, virtual reality simulation, computer aided learning, and distributed and networked multimedia over the Internet. These applications play a potential role in every field in society including education, training, business and recreation. Multimedia also helps to improve the lives of people with visual, mobility, speech, language and learning impairments with the help of special gadgets such as touch sensitive screens, head pointers, mouth sticks, speech synthesizers, modified keyboards etc. [Castorina 1994].

There is group of young people who cannot attend schools on a regular basis due to illness or injury, and who spend most of their time either in hospital or at home. ACCEL, with the help of its major sponsor, IBM Australia Ltd, has set about enhancing the quality of life and learning opportunities of these sick and disabled children, while attempting to understand the learning and teaching potential of the new and emerging technologies.

Starbright World, a nonprofit organisation developing interactive entertainment for ailing children, in its research on long term hospitalised children, showed a diminishment in the need for pain medication when only simple audio-visual equipment was provided for the children to use. In addition to relieving pain and stress, Australian Centre for Computer Enhanced Learning (ACCEL) has been helping sick children keep up to date with what is going on in their school. With this focus, ACCEL researchers have used the following questions to inform their work: Can multimedia help a sick child or a long term patient-student to:

- recover from illness?

- reduce the monotony, boredom and isolation at hospital/home ?
- keep in touch with his/her peers and school ?
- improve self-esteem and self-confidence?
- continue on the path of academic and social learning?

THE PILOT PROJECT

ACCEL, in partnership with the Royal Children's Hospital School, Melbourne and IBM Australia Ltd., developed a pilot project using multimedia video conferencing to link hospitalised and homebound children with their schools of origin. This technology (involving audio, video, graphics and text) operates over telephone lines and enables students to remain in close contact with school whilst learning new and creative technological skills. It is the intention of the project to provide the best possible avenue of opportunities for regular live visual contact between hospitalised and homebound students and their schools of origin.

The pilot project used *Person to Person*™ (P2P), a desktop multimedia video conferencing system developed by IBM. Desk-top video conferencing allows remote desk-top personal computer users to see each other, conduct meetings and work together on collaborative projects. P2P is very popular and has applications in the areas of Distance Education (Augusta Tech: Georgia and University of Michigan), Interactive Video Advising (Pima Community College, Arizona), Industry (Ford Motors at Michigan, Spain, UK) etc. To facilitate a link between a patient-student and another site using P2P, two personal computers are required with the following minimum configuration:

HARDWARE:

486 CPU 33 Mhz with a hard disk, 8Mb RAM, VGA or SVGA colour monitor, Mouse or Touch sensitive screen, Video camera/Camcorder, 14.4 kbps Modem, Action Media II video capture and playback adaptor, access to telephone line(s).

SOFTWARE:
OS/2 Operating system or Windows 3.1 /Windows for Workgroups and Person 2 Person for OS/2 or Windows.

PERSON 2 PERSON SOFTWARE

Person to Person has a number of features that make "electronic collaboration" as easy as dialing a phone or drawing on a chalkboard. The software includes shared talk and chalkboards, video conferencing, file transfer etc., as in Fig 1.

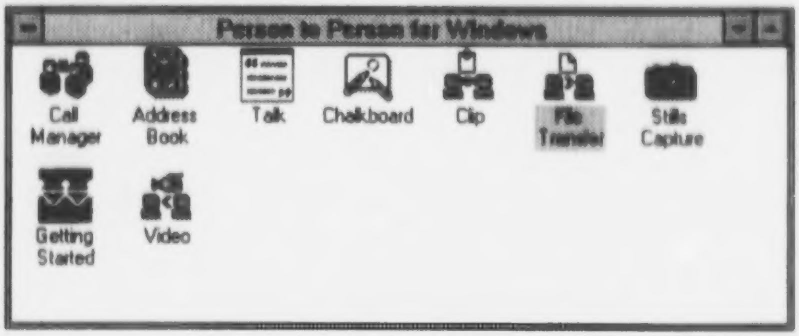

Figure 1. Person to Person program utilities

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BACKGROUND TO THE PILOT PROJECT

The original intent of the P2P project was to use multimedia technology to link long term hospital bound children back to their classrooms in their school of origin. This program will not replace the school, but it is believed that the program brings many benefits to a sick child. The aims of this project are to (i) enhance learning opportunities, (ii) provide immediate, direct contact with the school of origin, with other students and designated sites both academically and socially, (iii) enhance self esteem and self confidence, (iv) develop skills in on-line communication with other children, (v) provide an opportunity to gain a degree of control and 'normalisation' over part of their life through continuing their education.

During 1994-95, the project team investigated the potential of placing personal computers equipped with the necessary hardware and software in the Burns, Oncology, Orthopaedic and Neurology wards of the Royal Children's hospital and it soon became apparent that this was going to be difficult for three main reasons: (a) the technical logistics of the installation of the necessary equipment on these wards are daunting, (b) the demands of medical care and treatment interrupted stable links into schools and was too disruptive to timetables, (c) the reduced and unpredictable stay of student-patients; at the point when they could make best use of P2P, they were discharged to recuperate at home. This raised questions of cost-benefits and the issue of where the technology could be best utilised.

The P2P project team became aware of another group of children who are chronically ill and homebound and who are educationally linked into the Distance Education Centre, Victoria. Some of these students have at various times a dual enrollment with the Royal Children's Hospital School and Distance Education Centre. In view of the shared aims and common objectives in meeting the educational needs of these student-patients, Distance Education Centre was invited to join the P2P project. Another advantage of this involvement is that the Distance Education Centre can provide a stable environment together with current curriculum with an opportunity for flexible staffing.

PROJECT CASE STUDIES

Two long-term patient-students *Chris* and *Anthonella* have been selected for the P2P project. Both were in Melbourne's Royal Children's Hospital for some time and later sent home. Both children will require special medical attention for their whole lives. These two case studies will be used to evaluate and refine the project for future years. Both Chris and Anthonella were given similar hardware and software that meets the configuration explained earlier. The majority of this equipment and software was donated to the project by IBM Australia Ltd.

Chris , aged 10, has a severe uncategorised physical disability. He is the only known child worldwide with this condition. Although there is no name for his condition, some of the symptoms are similar to cystic fibrosis. Chris has a chest wall deformity, a small lung, severe scoliosis, and was born with missing ribs on his left side. His main problem is that his kidneys bind together on one side. Chris was able to attend school from his first year of schooling to the middle of his third grade. Chris's condition later deteriorated and his time in hospital has become unpredictable. Chris was unable to attend school as he required oxygen twenty four hours a day, and he tires easily. Another reason for Chris's inability to attend was due to his high chance of infection. Even so much as a common cold could hospitalise Chris for three or four weeks at a time. Although Chris cannot attend school on a full time basis, he would like to attend for a few hours per week. Until this option is a reality, his intellectual needs are being satisfied by a visiting teacher who sees Chris twice a week.

Due to Chris's inability to attend school for a number of years, his views about the importance of learning have not advanced far. He was keen to play games, but lacks motivation in areas covered by the curriculum in most schools. Through using P2P in conjunction with Dundee South Primary School, Chris was able to correspond with his classmates and see what was going on in his classroom. Linking to the classroom has proven to be very positive with Chris.

It was clear in Chris's case that the interaction with peers was able to show him many things about his own abilities, particularly that he was able to learn the skills needed to operate apparent complicated technical equipment, that then gave him contact with other children. He was also very keen to play computer games, which help to occupy his time and entertain him, in much the same way as his age group peers.

We must sadly report that Chris passed away late in 1996.

Anthonella, aged 12, has Xeroderma Pigmentosum, a rare incurable congenital condition in which her skin and eyes do not have the capacity to repair the damage caused by Sun light or Ultra Violet light. She attended school until 1990 but despite the best efforts of the school she was unable to continue due to the development of potentially fatal skin cancers caused by the high level of exposure to UV light under normal school conditions. She was at risk due to the high level of exposure to UV lights in the school buildings and sunlight could not be effectively screened out. Now, she cannot attend school, visit a playground nor even go out of the four walls of her house due to exposure to the sun's UV rays. Her skin is even sensitive to neon, and halogen lights. Her schooling is now in her own home under a 60-watt incandescent electric bulb. "A lot of the time I feel I am alone in the middle of nowhere, with nobody" says Anthonella. Anthonella is a very able and conscientious student. However, her isolation has impinged on her educational progress and she has been in danger of falling further behind her peer group in both educational and social skills.

Since 1991, Anthonella has been restricted to her home and has continued her education through the Distance Education Centre, Victoria with a weekly visit from the visiting teacher service. Anthonella's personal computer is fitted with a special anti-radiation screen in order to avoid her being exposed to the radiation emitted by the computer's video display unit.

She is a highly intelligent young girl whose forced isolation was having a major negative impact on her self concept. She was able to see the long term issues for herself of her isolation. It was impossible for her and indeed her very supportive family, to see a worthwhile future. After the implementation of this P2P project Anthonella said "This has changed my life. I like this program so much I spend all day with it. I just do not remember what I used to do if I didn't watch television". This dramatic sounding response is becoming increasingly more accurate for Anthonella. Her view of herself and her world has changed. She sees her developing skills as offering her a window to the outside world now and potential employment from home in the future. She is now considering a variety of occupations for herself, with the full realisation that she is a "night person", but not letting that fact limit her imagination.

Not only is she rapidly catching up to her school-based peers educationally, but emotionally as well. She has gained confidence and now speaks fluently to people she meets both personally and virtually. While her normal academic learning is progressing well, she is becoming highly proficient as a user of technology, in a very real way, doubling the learning required for her school-based peers who do not have access to the technology that Anthonella has.
With the P2P project, Anthonella can now access directly the Distance Education Centre via the multimedia technology, link with other home bound students, and be a more active participant in her studies and gets the desperately needed social interaction with her peer group. She also now has an email address through Victoria University of Technology, and regularly corresponds with university researchers.

PROJECT CONSTRAINTS

Several constraints were encountered while using the P2P conferencing:

1. Live video between the patient-student and the school is very slow over telephone lines. Real time video requires the transmission of 20 to 25 video frames per second. Even with a fast modem (28.8kbps) it is possible to send only 2 to 3 frames per second over the existing telephone lines. Again, to use the audio link, a second telephone line is required. These problems (video frame rate and audio link) could be solved to some extent by using an ISDN connection. However, the other utilities of Person to Person program including the *File transfer*, *Still video*, *Talk* and *Chalk board* work effectively with the existing telecommunication technology.

2. The Dundee South Primary School has only two telephone lines connected to the school, one to the office and the other to fax machine. Whenever the school wants to link up with Chris, they have to disconnect

the Fax machine and use that line to establish a connection. This interrupts the normal school office functions. An additional dedicated line is required for reliable communication with Chris.

3. Support for extension and maintenance of the project: IBM Australia Ltd., generously donated hardware and software, and have been very supportive in a long-term ongoing fashion. Additional funding is required for charges associated with telephone lines, printers, computer specific furniture, video cameras, modems, software etc.

FUTURE OF THE PROJECT

Much of the success of this project rests with the motivation of the patient-students involved. This had led the project team to question current classroom pedagogy and its appropriateness to these children, and indeed any implications this may have for all children in conventional settings.

We have noted profound enthusiasm in the children on the project. They are self motivated when they do not have other classroom-type tasks to perform, and, of course, are also very able in their completion of set classroom tasks. The research team is currently considering alternative approaches to learning that access to this specialised technical equipment allows for the first time in history. These children have already developed technical skills far surpassing the vast majority of primary school teachers in Australia. Their own future employment prospects probably will rely on their expertise. It therefore seems appropriate that they are given different options to learning styles than what is on offer in mainstream Australian schools. We feel that connection to Internet and the World Wide Web in its emerging form, will offer many things to these children, and have therefore given access to it.

Internet is growing at exponential rates and is easily accessible by anyone from anywhere in the world. It is assumed that by using the Internet services a patient child can turn the hospital room into a playground, a classroom or a family home. Access to Internet services is provided through a dial-up service at Victoria University of Technology using Serial Line Internet Protocol (SLIP) as shown in Fig 2. The hardware and software for the patient-students will soon be upgraded to give maximum performance under normal conditions and they will be trained in how to use the new equipment and software, although their expertise with the current equipment suggests that little training will be necessary. An *Internet Filter* will be installed, in consultation with the children's primary care givers, on both the machines to filter out any obscene and sensitive information arriving at Anthonella's computer via Internet.

The advantages of linking Anthonella to the Internet are many. For instance, using *Electronic-mail*, Anthonella can communicate electronically with friends, peers, teachers, and also with Royal Children's Hospital School and the Distance Education Centre. They can virtually meet other patient-children, share their experiences, exchange messages about their illnesses, or play on-line games. They can participate in collaborative projects through discussion groups like International Electronic Classroom Connections, K-12 projects etc. Currently, Anthonella is "voting" for email by using it frequently. We have informed Anthonella that we keep records of everything she sends us, and she has been very obliging. Her first message read "Just sending you a test", and her most recent message was a full page of text. The longest delay between messages has been two days. It is obvious by her use of this facility that she loves it.

Using *Telnet*, Anthonella can widen her knowledge by remotely logging into worldwide Databases, Libraries, NASA, and other locations. *File Transfer Protocol* allows her to send and receive assignments from school, and with *Internet Phone* she can conduct inexpensive real time audio conferencing with specialists anywhere in the world.

The P2P video conferencing may be supplemented with *CU-SeeMe* on Internet. *CU-SeeMe* is a free video conferencing program over the Internet that allows desktop video conferencing with another site located anywhere in the world. Unlike P2P, it includes audio and to receive video no additional hardware is required. The video transmission (frame rate) is dependent on the IP network traffic. Using this technology, Anthonella may be linked to her school/Distance Education Centre to have real classroom experience and to interact with teachers and peers in real time.

WorldWideWeb (WWW) is enhancing knowledge and learning opportunities through its hyperlinks to worldwide multimedia databases, hypermedia documents and virtual reality projects. Anthonella hopes soon to create her own home page on the web using HTML. She can participate in on-line interactive projects such as the *Interactive Frog Dissection Project* on WWW or connect to *Starbright World's* interactive, multiuser, point-to-multipoint network to talk and play with other children irrespective of their physical condition or geographical location and share *Starbright's* interactive, virtual reality environments. Currently, however, Anthonella, as any normal little girl, is keen to discover pictures of her favourite movie stars. And they are all male! The desire to gain this specific information in itself has ensured her asking lots of technical questions to develop skills she requires to solve her immediate problems.

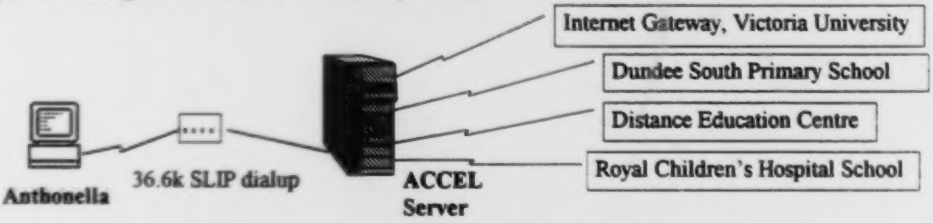
Internet Gateway, Victoria University
Dundee South Primary School
Distance Education Centre
Royal Children's Hospital School
Anthonella
36.6k SLIP dialup
ACCEL Server

Figure 2. Internet access for Anthonella via ACCEL server

It appears, therefore, that the children on the project will require continuing training in the use of new equipment and software. These are their learning tools. Given these tools, particular content for their learning can be an area for local negotiation. The research team will be looking at these issues in the coming months.

CONCLUSION

The P2P multimedia project seems to be especially significant for young disabled students like Anthonella where the disability is not temporary like a broken arm, yet may not be immediately life threatening. It is envisaged that with the successful development of the P2P project and the support given by ACCEL, IBM Australia Ltd., Royal Children's Hospital and Distance Education, Anthonella having completed her primary education and commenced her secondary education this year will eventually have access to a tertiary qualification. In the long term there is also the potential for Anthonella to develop a career and open employment opportunities (which could operate from a home computer), given that she will always need to live and work in a highly protected environment.

The P2P project is pushing the barriers of new technology to enable people in a variety of circumstances to have access to open learning and employment opportunities which are currently not available to them. It is humanitarian in its ability to change the lives in a most positive fashion of sick and disabled children. The project is limited only by the availability of finance to support the acquisition of equipment and expertise to facilitate its wide spread implementation.

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ASML: Web Authoring by Site, Not by Hindsight

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Abstract: This paper describes Automatic Site Markup Language (ASML), a revolutionary new web authoring system. ASML is a markup language designed to support web authoring at the site rather than just the page level. Often web-site designers find themselves plagued by hindsight as they wish they had chosen a different page layout or navigation graphic. Educational users in particular find it difficult to define at the beginning of a project just what a site will look like and how it will evolve. ASML provides a single solution for site level authoring wherein common content exists in only one place. It also provides for logical rather than physical organization of projects, simple searching and indexing, and CGI scripting without resorting to custom programming. Support for derivative sites is a unique feature which is very useful in classroom support environments.

Introduction

The World Wide Web (WWW or web) has become a valuable tool for the distribution of educational materials. Class notes, tutorials, and lectures can be electronically distributed at low cost. However, authoring these materials in a high-quality form can be time consuming and frustrating. Page layout, common graphical elements, and site structure become integral parts of hundreds or thousands of web *pages* and are difficult to change. Custom programming is required to make simple corrections, handle form data, or provide any sort of dynamic content.

The Dartmouth Experimental Visualization Laboratory (DEVLAB) has been involved in electronic publishing since its inception and has produced several large scale web projects including *The Ancient Olympic Games Virtual Museum* [DEVLAB 1996], and *The Prehistory Archaeology of the Aegean* [Rutter et al. 1996]. This experience led to the development of Automatic Site Markup Language (ASML) [Owen et al. 1997], a new markup language for the production of World Wide Web *sites*, not just pages. ASML treats a web publishing project as a single large document rather than a collection of disjoint pages. It centralizes common functionality, decreases redundancy in the site description, and replaces many uses of scripting languages and other programming efforts in site construction. It is a single, cohesive, tool providing authoring, scripting, searching, and indexing features. This paper presents an overview of ASML and its use in courseware production. A complete description of the system is available as a technical report [Owen et al. 1997].

In ASML terminology, a *site* is a single web production. As an example, the Prehistoric Archaeology of the Aegean is considered a site, even though it coresides on a server with other web publications. The ASML terminology for a complete server is a *server-site*. [Fig. 1] illustrates the use of ASML at a site. ASML format content, as well as imported content (images, RTF, HTML), are processed to produce the site publication which is served in conventional forms. ASML does not introduce a new distribution standard at all. It also inflicts no performance penalty. Production of web sites using ASML can be likened to producing documents using a word processor, where the author does not edit the final document format at all (Postscript, for example), but rather edits an intermediate format (Microsoft Word). The conventional approach of producing a site as individual HTML pages is very much like directly editing Postscript to produce pages. More precisely, it's like editing one Postscript document per page. This page-at-a-time approach severely limits global site changes. Inevitable reformatting and content restructuring requires computer programs which iterate over all pages of the site and make changes. It is common to hear authors say that they are unhappy with a graphic in their site and wish they had chosen a different one in hindsight. ASML allows a site to be described *logically*, with common elements stored in one location, so reformatting a site requires minimal changes to site *templates* and a rebuild

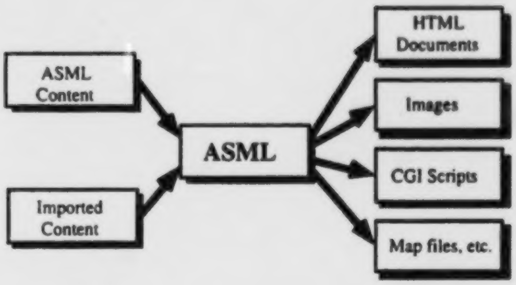

Figure 1 - Use of ASML at a site

of the site (which is automatic and takes only a few seconds). This approach is called *site-level authoring* and is a basic feature of ASML.

There are many site-level authoring approaches. The most common is the production of scripts in some programming language which either edit all content in an existing site, produce a new site from raw data, or generate a site from content hard-coded into the programs. The Perl programming language [Wall & Schwartz 1991] is a common tool for this task due to its wide availability and block quoting capabilities. Other systems include Frontier from UserLand software, a popular Macintosh Environment [UserLand 1997]. Use of these systems is summed up by Hall and Tews in a MacWeek review of Frontier: "Scripting in Frontier is by no means a job for beginners..." [Hall & Tews 1996].

Carl Davis has created a large list of graphical HTML editors with reviews [Davis 1996]. Site-level features are rare in editors, the majority of which are designed for single page editing. Web Project Explorer from Haht Software incorporates a system of "Clips", which are very similar to ASML templates [Haht 1997]. However, clips are static macros which contain fixed content, as distinct from ASML templates which allow variable content. Web Project Explorer has site level organization and visualization tools, but retains a page-at-a-time editing and composition approach.

A large number of education specific approaches to site-level authoring and automatic content generation have been devised. ANDES Text Markup Language (ATML) is a markup language, much like ASML, but is specific to the ANDES distant education system [Johnson et al. 1996]. CourseWeaver is an Apple Hypercard-based system designed for development of courseware for the web [Rebelsky 1997]. It uses a custom markup similar to that of ASML, provides for multi-targeted output, and handles content input translation. ASML was designed with many of the same objectives as these systems, but is not specific to education or any other application, and, as such, does not enforce any standard page layout, navigation mechanism, or site structure.

ASML Features

ASML has many features. This section provides an overview of some of these features and describes how they apply to educational users of the web. ASML is an integrated system, not a collection of programs. The following features are all integral parts of the ASML environment.

Simple Markup Format

ASML uses a simple markup format designed to be familiar to the HTML user. ASML does not supplant or replace HTML. HTML can be freely used in ASML documents. HTML is a very fluid standard. Graphical editors often attempt to hide markup from users with limited success. ASML does not introduce that limitation. Instead, ASML can be considered an *extension* of HTML. ASML functionality can be added to an existing page by simply adding ASML markup. The page is then processed to produce the published HTML version.

ASML uses a markup format of tags, end tags, attributes, and values identical to HTML except for the use of { } as markup delimiters rather than < > as in HTML. HTML and ASML can freely coexist in the same document and are easily distinguished. An image inclusion in HTML and ASML might use the following tags:

```
<img src="/bronze/images/bar.gif" width=400 height=10 alt="---" align="center">
{img src="/images/bar.gif" alt="---" align="center"}
```

The structure of the tags is very similar. The differences are related to the automation features of ASML. The width and height attributes are determined automatically and need not be included. The image source in ASML is relative to the site directory tree, not the server directory tree, a characteristic of *location independence*.

The term *expand* will be used throughout this document to indicate the processing of an ASML tag. Every ASML tag is expanded and no ASML tags remain in the output (except when specifically added using an escape mechanism). Browsers need not be modified to support any ASML syntax. Indeed, ASML is invisible to the WWW user. Some ASML tags have conditional and repetitive processing functions and some tags expand to empty content.

ASML comment sequences are delimited by `{--` and `--}`. Comments are completely ignored by ASML. They are not translated to HTML comments or reproduced in any way in the output page. HTML comments are often underutilized due to the fact that any user can view the source of a page and see the comments and they increase the transmitted file size. ASML comments are available to the site author, but not the casual user. Question solutions or personal notes can be placed in comments with no fear that students will "view source" and read them.

The markup format is easy for an HTML user to learn, but does represent a tradeoff. It conflicts with the use of braces in cascading style sheets [Lie & Bos 1996] and JavaScript [Netscape 1996]. An escape mechanism is in place to accommodate this usage, but is somewhat cumbersome to use. A future extended quoting mechanism is under consideration for simplifying this usage.

Templates and Site Level Content Generation

Web sites contain large amounts of redundancy. Navigation methods and page appearance are kept consistent. Graphic elements are used repetitively so they will stay in the browser cache. Ideally every site development project would define these elements up front. Skeleton pages could then be used to create the site. However, content acquisition often proceeds in parallel with style and format design and some sites, particularly educational sites, are subject to indefinite evolution. And, of course, there's always someone who hates the purple graphic and wants it changed in all 318 pages.

Templates are the mechanism in ASML for defining repetitive content. A template can be created for a graphical element, page elements, entire pages, or entire sites. A template is very similar to a macro. A template expansion in ASML is initiated with a tag, for example: `{pagetop title="My Home Page"}`. Parameters on templates allow variable content. Templates are defined using the `{define}` and `{append}` tags. An example template usage might be the definition of a template for a graphical separator in a site. The ASML markup for such a template definition might be:

```
{define name="separator"}{img src="/image/sep.gif"}{/define}
```

This template could then be placed at any point in the text using the `{separator}` tag. The `{define}` tag need be at only one place, often in a file which defines format elements for a site. Changing this one line changes the separator everywhere it is used.

ASML templates are more than simple parameterized macros. They can store variable content, implement counters, and include conditional and repetitive content. Content can be multi-targeted using templates, so it is very easy to construct an automatic table of contents. Multiple simultaneous tables of content can be used in the same site and can be formatting in any form desired including tables and graphical bullets.

Logical Modularization

HTML enforces a specific organization of site content. A file is equivalent to a page and groupings of content are physical groupings, typically defined by the directory structure. Large numbers of small files can be difficult to manage. Any site can be represented as a single ASML file. However, it is usually much more efficient to break this file into smaller, more manageable units. The big difference is: the modularization can be *logical.* One file may contain format elements which are common for a site. Another may contain all content on a given topic, even though the final site will divide that content among three pages. Logical modularization allows a site to be broken into components which are sensible for the user rather than the delivery mechanism.

Derivative Sites

Educational sites are often *derivative sites*, sites where content is derived from an alien format. The Prehistory Archaeology of the Aegean site is an example derivative site. This site is based on a large set of class notes by Prof. Jeremy Rutter of Dartmouth College. The site is meant to be supplemental to the notes which are also provided to students in a bound form. The web site presents the same material, but is searchable, provides the images in full color, and has links to other content. The class notes are expanded regularly and Prof. Rutter wishes to maintain them in a word processor format (Microsoft Word) so that they can be easily printed.

ASML supports *imported content*, content supplied in forms other than HTML or ASML. In the DEVLAB production of the Prehistoric Archaeology of the Aegean, the content is provided as Rich Text Format (RTF) exported from Microsoft Word. That content is imported into ASML when the site is generated and used to construct the pages. The original Word document becomes a source for compilation of the site. Whenever that document changes the site can be rebuild, completely incorporating the changes. This is importance in any application where content routinely changes and must appear as both paper and web documents. A derivative site is distinct from a *translated site* in that the content in a translated site undergoes a one-time translation to HTML. Later revision of the content requires either a new translation or a manual search for the changes.

Multi-targeting and Location Independence

Multi-targeting is the ability to produce identical content in more than one format. Providing both a "frame" and "frame-free" version of a site is an example of multi-targeting. ASML allows content to be shared among multiple formats freely and, therefore, supports multi-targeting. *Location independence* is the ability to produce a site at any required server address. This is a basic feature of ASML. Using the `{base}` tag, content can be relocated at will. In several DEVLAB projects this feature has been used to maintain simultaneous development and publication sites for the same project. The published site was updated occasionally when the content reached stable milestones. The development site contained content in incomplete stages. This feature is also useful when sites move from a development server to a publication server.

Content Indexing and Searching

ASML has a built-in indexing system and search engine. Indexing a site requires only the addition of the `index` attribute to page generation and a single `{index}` tag specifying the file name for each index. Multiple indices can be constructed for a site allowing content can be categorized. As an example, the Prehistoric Archaeology of the Aegean site has three major categories of content: lesson text, images, and bibliographies. The ASML search engine is easy to implement using only ASML (no Perl scripts or other alternative tools).

The ASML search engine is based on an index file constructed when the site is built, allowing for very fast search operations. Search results are obtained quickly with minimum load on the web server. The search engine scores pages which match the query and ranks the pages in descending relevance. A unique feature of ASML is *search highlighting*. A page located using the search engine can be accessed with all search terms highlighted in red. In addition, the browser is automatically advanced to the first search term located in the document.

Simplified CGI Scripting

Beyond the programming world the term *Common Gateway Interface* (CGI) strikes terror into the hearts of developers. HTML is highly intuitive, easy to learn and use, and very forgiving; Perl is not! But, scripting is necessary for the generation of dynamic content and processing of data forms. ASML can serve as the sole scripting mechanism in many applications. Production of a script is little different from production of a page. Form variables are automatically acquired and converted to templates by ASML. All issues of CGI protocol are managed by ASML, requiring no user knowledge of the underlying mechanisms.

A Brief Tag Summary

A complete list of ASML tags is beyond the scope of this paper and is available as a technical report [Owen 1997]. There are over two dozen basic tags and this set is easily expanded using the template mechanism. The tags can be grouped into several categories: template management (`{define}`, `{append}`, `{definelist}`), environment (`{base}`, `{include}`, `{page}`), CGI and form support (`{formget}`), searching and indexing (`{index}`, `{search}`, `{highlight}`), conditional and iterative execution (`{if}`, `{else}`, `{foreach}`), HTML enhancement (`{img}`), and derivative content (`{import}`, `{section}`). (Not a complete list.)

Courseware Production using ASML and an Example Site

DEVLAB development of ASML has been driven by real-world applications. Many DEVLAB web projects involved first year college students with no experience in programming or HTML. Skilled programmer labor is often difficult to come by due to the demands of many research projects. Every effort has been made to move programming labor from site-specific detail to the general ASML environment and provide a user interface that students with negligible experience can comprehend and use.

The Prehistoric Archaeology of the Aegean

A major courseware project at the DEVLAB has been the Prehistoric Archaeology of the Aegean [Rutter et al. 1996]. [Fig. 2] shows two pages from this site. This project uses nearly every feature of ASML and is an example of ASML use in courseware. It also provided a large amount of user testing. The site includes 29 detailed lessens in archaeology and is designed for student use. Over 500 images of archaeological digs, historic locations, and significant artifacts are included in the site. All images are presented in a small browsing format, a larger display format, and the full high-resolution scan size.

The site is a *derivative site* and can be reconstructed as the content is updated (indeed, it has been updated several times). The content is imported as RTF text. The ASML search engine is an integral feature of the site and four indices are generated. The pages which present the images are generated dynamically by an ASML CGI script. The page layout and navigation mechanisms were changed repeatedly in the process of site development. In spite of the fact that this site incorporates more than 100 pages, it is produced by 14 ASML files with a total of only 1759 lines. Over a third of these lines are a list of the available images.

Summary

Courseware authors need new approaches to World Wide Web development which eliminate redundant effort and allow sites to be created as coherent documents, not collections of pages. ASML is one such approach. While retaining the simple and well known structure of HTML and total compatibility with existing technology, ASML provides numerous high-level facilities including centralization of common page elements, derived sites, and indexing and search. Use of these features is painless and an HTML user can expand to ASML functionality with minimal effort. In many cases ASML can replace custom programming in site development. ASML is currently in version 1.03 and many new features are planned. More information on ASML can be found at `<http://devlab.dartmouth.edu/asml/>`.

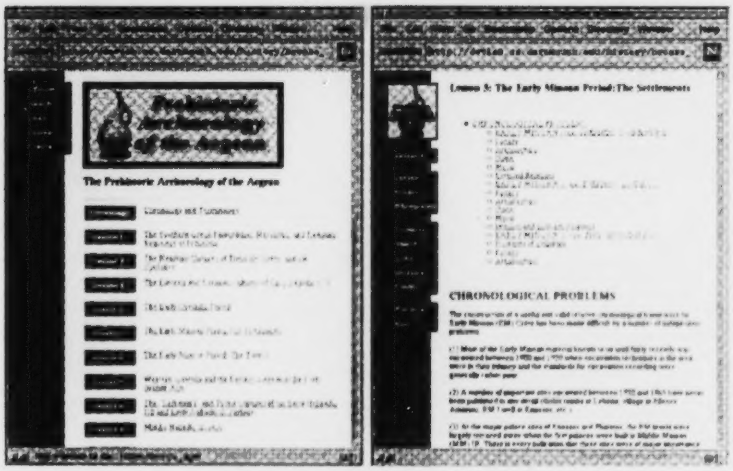
Prehistoric Archaeology of the Aegean
The Prehistoric Archaeology of the Aegean
Lesson 5: The Early Minoan Period: The Settlements
CHRONOLOGICAL PROBLEMS

Figure 2 - Prehistoric Archaeology of the Aegean site

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BEST COPY AVAILABLE

Point-and-Click Construction of Comic Actor Animation Sequences

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Abstract: Adding animated comic actors to courseware is usually very time-consuming and tedious and requires expert knowledge. Using our approach, this task becomes a matter of simple point-and-click actions.

Only once per character, a professional graphic artist must create a set of elementary animation sequences conforming to our approach. From then on, any courseware author can graphically specify an entire storyboard using our Comic Actor Sequence Editor (caSE). caSE uses a sophisticated approach for combining the elementary building blocks into a complete animation.

Our comic actors can be integrated with multimedia documents, but also with arbitrary interactive software, e.g., help agents. Using a digital chroma keying technique, our Comic Actor Playing Engine (caPE) displays the animation transparently on top of any graphical user interface.

The system runs under MS Windows; a first version is used in a public interactive exhibit about animation techniques and shows excellent performance.

1 Introduction

A primary concern in computer-aided instruction lies in both the effort and expertise required to create instructional material. The learners' expectations raised by the word "multimedia" may boost the relation of authoring time to courseware unit length (in hours) by another order of magnitude. Even worse, decent multimedia courseware authoring requires subject matter experts, artists, and computing experts to cooperate. Many courseware authors are unable to organise or finance such a coordinated effort.

Animations have often been viewed as the most valuable time-based media to be integrated into courseware, being more effective than live video and audio. But animations can not only illustrate technical processes, they can greatly enhance learner motivation, interest, and retention rate. In particular, animated cartoon characters can be used in numerous ways, both as part of multimedia (courseware) presentations, and as an add-on to software user interfaces (e.g., as part of the online help system).

In order to greatly reduce the effort required to create animations, we developed a two-step concept and implemented it with a focus on animated cartoon characters which overlay other presentations (documents or software user interfaces):

- First, an artist creates generic building blocks for a certain class of animated cartoons.
- These building blocks are integrated into our comic actor sequence editor, caSE. caSE can then be repeatedly used by numerous subject matter experts in order to build custom animated cartoons. This activity is reduced to a number of easy-to-learn graphical ("point-and-click") actions.
- At runtime, our comic actor playing engine, caPE, displays the animated cartoons synchronously with the underlying multimedia document or software user interface. caPE is based on a "digital chroma keying" approach and is conceived such that interoperation with arbitrary software or presentation tools can be achieved.

1.1 Structure Of This Paper

In the following section we are reflecting on the state of the art. In the remainder, we will describe the general concept of generic building blocks for animated sequences (in this case animated cartoon actions) and their composition ([Basic Concept]).

The sections [caSE: A Generic Comic Actor Sequence Editor] and [caPE: The Comic Actor Playing Engine] describe the caSE editor and the caPE engine, respectively. A summary will conclude the article.

2 Related Work

Gibbs and Breiteneder [Breiteneder & Gibbs 94, Gibbs et al. 93] discussed the use of video widgets in the form of video actors. They used a hybrid analog/digital system and a layering technique that is very expensive to implement as digital-only. Their straight forward building-block approach was provided as a C++ class "VideoActor". We preferred affordable digital-only technique since we target MS Windows™ PC typical for CAL teaching environments; we rather concentrated on a more sophisticated automated building-block approach.

The construction and integration of digital actors is described by Magnenat Thalmann and Thalmann [Magnenat Thalmann & Thalmann 95]. The use of facial animation is also discussed there. Owen and Willis [Owen & Willis 94] are modeling and interpolating cartoon characters using NURBS. These approaches focus on specialized, closed-shop presentations and usually require powerful graphics tools.

We saw our main task in integrating comic actors with separate applications and with the graphical user interface. Therefore, we left the problem of drawing and animating to specialists, and concentrated on the composition of custom animations from building blocks.

Cartoon characters as help agents become more and more popular (cf. MS Office '97™ and Lotus Notes™). Such characters, however, are custom designed in a huge effort and nevertheless usually "sit in a corner of the screen" instead of walking to and pointing at UI objects.

Multimedia authoring tools such as Macromedia Director™, IconAuthor™ etc. include animation support, but only at the "low" technical level which our approach limits to the professional designer's task. User-friendly notion of story board actions and intelligent combination of building-blocks into such actions as with our caSE tool are not intended.

3 Basic Concept

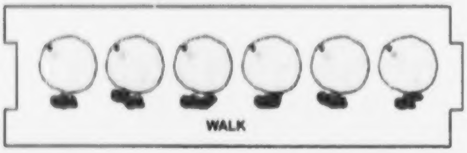

Figure 1: Illustration of the 'walk' building block [1].

The basic pieces of animation that are used as building blocks for complete animations are created by graphic artists. These animation sequences have to provide exact matches to other sequences.

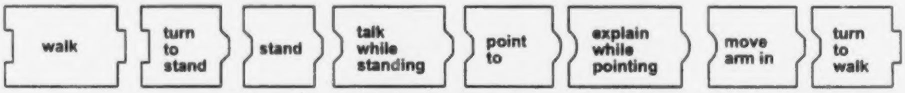

Figure 2: Some example building blocks with matches.

This way an author can, e.g., create a walking sequence by using the building block 'walk' (one step) repeatedly. Based on the distance between two points on the screen and the distance the actor advances in the animation sequence, the number of necessary repetitions of the sequence can be calculated. The animation for walking (some steps) between these two points can be created automatically.

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[1] This comic actor represents an Upper-Austrian dumpling.

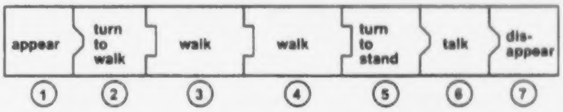

Figure 3: An example animation made from building blocks.

In order to prepare the system for a certain class of animated cartoons, one has to determine which actions the character should be able to perform. The sample actor described here should be able to 'walk', to 'stand', and to 'point' somewhere. While standing or pointing it should be able to talk to the user using either balloon or digital voice output.

The minimal set of matches needed to connect the animation sequences has to be determined. To describe their correlation, the matches and sequences are mapped onto states and transitions in a state transition diagram, cf. [Figure 4].

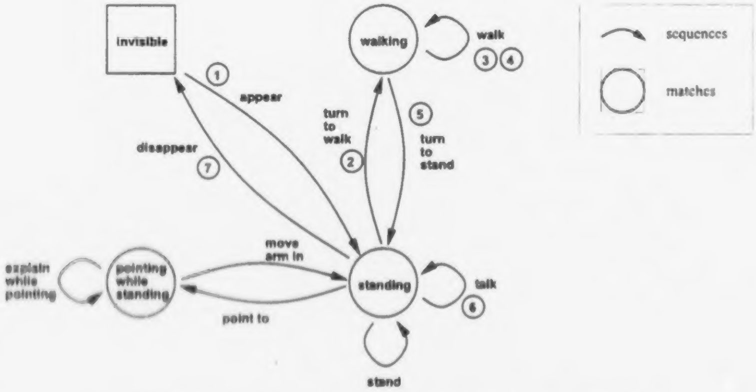

Figure 4: State transition diagram for animation example.

This example is modeled by three states (plus the 'invisible' state) for the following reasons: Every state in this diagram is equivalent to a match between building blocks (animation sequences). It is useful to keep the set of matches small, in order to keep more degrees of freedom for the composition of the building blocks, cf. [caSE: A Generic Comic Actor Sequence Editor]. Building blocks are represented by edges in the graph. The set of edges has to yield a strongly connected directed graph [Manber 89]. Given this condition, every constructable animation can be represented as a path in this graph (cf. numbers in [Figure 3] and [Figure 4]).

Every different comic actor is characterized not only by its animation sequences but also by his individual state transition diagram. A comic actor "bird", e.g., would have a quite different state transition diagram than our "dumpling" example.

4 caSE: A Generic Comic Actor Sequence Editor

4.1 Animation Sequences

Once an artist has completed the design of the generic sequences (building blocks), he must specify the matches (represented by a state in the diagram). Each match has to be named. After specifing the matches used, the sequences are introduced into the editor caSE.

For each sequence a set of properties is required: *A unique name*, the *directory path to the animation data-files*, the *matches* (Which states does the sequences' transition in the state transition diagram connect?), the *length* of

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the sequence (frame rate and tolerance), the *default distance* (shifting over the screen) the sequence was designed for, the *movability* (Is the sequence to be played on a fixed position or can it be moved over the screen?), the *angular range* in which it can be moved (e.g., 'walk right' [-45°, 45°]), the *position of the character* in the sequence, and the *position of the hot spot* (e.g., for pointing).

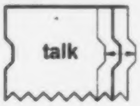

Figure 5: Tolerance in frame rate: adjustable length of sequences.

This information makes it possible to use graph algorithms [Manber 89] to cope with emerging problems: It can be checked if there are enough sequences introduced to cover the given states, by verifying the strong connection of the resulting directed graph. In addition the editor can find missing sequences if the user requests to add a sequence that is not linked with the current match. This can be done by searching the shortest path to the start transition of the requested sequence.
Example: The actor is 'talk'ing. The user wants the actor to walk. Now the editor can detect that the sequence 'turn to walk' is missing and insert it into the animation.

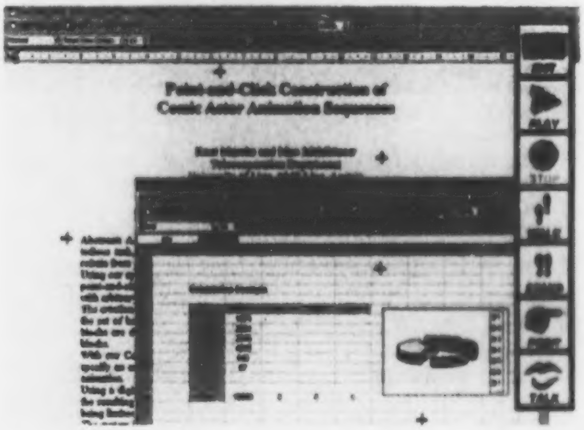

Figure 6: On-screen editor - the animation follows cross marks

We have already built a specialized editor prototype, and are working on a generic one by using the approach described in this paper. Our specialized editor implements all actions shown in [Figure 4]. It offers four actions: 'stand', 'walk', 'talk', and 'point'. Missing sequences are inserted automatically without requiring user input. All positions needed are marked directly on the desktop, where a simple cross indicates the position, cf. [Figure 6].
Additional input can be given via a popup window: For every sequence an accompanying bitmap (e.g., a balloon with prepared text) and the position of this bitmap relative to the sequence can be specified. Audio sequences can be included using WAV-files; these are played asynchronously from the beginning of the sequence. Cf. [Audio Sequences] for further discussion of this problem.
The editor saves a text file which contains all the data needed by the playing engine described below to perform the animation directly on the graphical user interface. The playing engine can be invoked and stopped directly from the editor.

4.2 Audio Sequences

Audio sequences cannot be adjusted in speed or length. For this reason it might be necessary to adjust the corresponding animation sequences in their length or frame rate.

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Concerning the tolerance in the playing time of one animation sequence, the following considerations have to be made: The longer the audio part, the better it fits to its animation sequence because the animation sequences are relatively short and have to be repeated for a longer duration. At a certain number of repetitions n the tolerance of the used animation sequence t results in a tolerance of $n*t$ for all repetitions together. Otherwise the animation sequence has to be cut off or may have a (short) period without audio. This can be decided by the user.

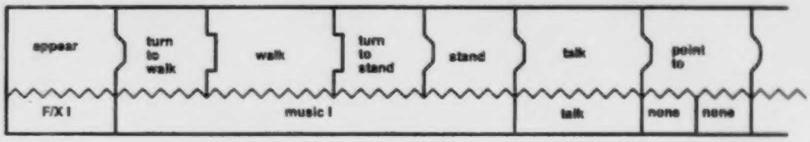

Figure 7: Combination of audio and video blocks.

5 caPE: The Comic Actor Playing Engine

5.1 Preparing the Sequences

To specify the transparent portions of the sequences, we built a tool which leverages off Apple's QuickTime technology [Apple 94], cf. [Figure 8]. Keying colours are selected by marking rectangular regions of any frame in a sequence. Every colour found inside this region will be transparent for the whole frame, in every frame of the sequence. This tool then saves the sequence in an internal file format which we custom-designed for performance reasons.

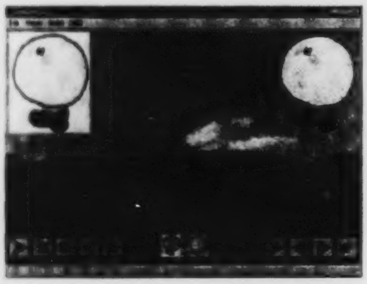

Figure 8: BlueMotion, a tool for specifying transparent portions of sequences.

5.2 On-Screen Chroma Keying

The playing engine displays the animation on the graphical user interface. It is currently implemented for MS Windows NT. The animation sequences belonging to the animation (described by an input text file generated by the caSE editor) are displayed directly on the desktop.

The engine can be used as a command-line executable or as a DLL version. The DLL version is always interruptable by the calling program and will be enhanced by a messaging concept to have more synchronization capabilities. At the end of every sequence an `END-OF-SEQUENCE` message is sent to the calling application.

The command line version is useful to integrate the comic actor functionality with standard multimedia authoring tools, e.g., Multimedia Toolbook, Macromedia Director, or even standard applications like MS Word or MS Excel.

We also experimented with sending mouse messages, e.g., to make the actor press buttons. However, the problem is that the runtime position of buttons cannot be predicted or found out for arbitrary applications: The IDs of buttons are assigned at runtime, and names of buttons are not unique. Nevertheless this feature can be used in customized applications or if a button will not change its position. A counterexample for buttons on fixed positions are the moving and vanishing toolbars of most MS Windows applications.

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Up to now, our actor has to run on top of all other applications and still has some problems when the underlaying windows are updated during animation. We are working on this synchronization problem. By using a standard Pentium PC (133 MHz) we obtain 20 frames per second using sequences of size 320x240.

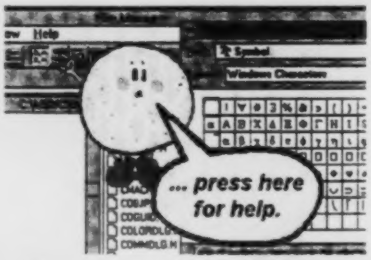

Figure 9: On-screen chroma keying.

6 Summary and Future Work

A version of our editor was shown as exhibit in the Ars Electronica Center, Linz, Austria. There it is also used as tool for courseware authoring in the "Conference/Classroom of the Future" (CCF) [Mühlhäuser et al. 96]. The animations created with our editor are used to explain the technical and pedagogical content of the CCF. The intuitive handling of the editor pleased many users. Quite often, a more generic tool where own animation sequences can be introduced was desired. Our playing engine, we are still working on, does the on-screen chroma keying with excellent performance and imperceptible cuts (matches) between different animation sequences.

In the near future, we intend to finish the generic comic actor sequence editor by using the approach described in [caSE: A Generic Comic Actor Sequence Editor]. This editor should also be able to control more than one sequence, e.g., two actors that interact with each other.

Apart from that, we are working on interaction of the actors with the user interface. Not only by pressing keys or by opening windows, but also by pushing windows away or pulling windows onto the desktop, the integration of actors with the user interface will increase.

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Courseware Development for Parallel Computing and C Programming

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Abstract

This paper discusses the construction of online World Wide Web based courseware within an educationally sound framework. Two courses are used as illustration, parallel computing and C programming.

1 Introduction

In recent years much attention has been paid to the delivery of teaching material over the World Wide Web. A variety of approaches have been adopted ranging from the provision of on-line lecture notes, exercises and their solutions to more interactive teaching packages. Also the intended method of use has ranged from lecture support to self-study packages.

The Dept. of Computer Science, University of Cardiff has been active in this field for a number of years and has developed courseware of varying degrees of support for a number of courses.

This paper will address the issues of implementing courseware two of its more *mature* lecture courses and details their use in a class environment. Throughout the whole of the courseware design and development we have paid close attention the educational effectiveness of the design model and presentation of the courseware. In particular this paper addresses issues of how best to provide information in such a hypertext based system and how interactive packages can be developed.

2 Module Development Strategy

Developing courseware is not merely a matter of preparing a series of lectures, linking them together and packaging them as a course. A comprehensive design strategy must also consider how to implement and manage a course, how to evaluate the materials that are used, and how to assess the learners. With that in mind, there was a conscious effort to take a systematic approach to the development of course materials. According to Rowntree [Row82] the systems approach should incorporate four basic stages: *(a)* Identify course aims and objectives; *(b)* Develop necessary learning experiences; *(c)*Evaluate the effectiveness of learning experiences; and *(d)* Improve the experiences in the light of evaluation

2.1 Stage 1: Identify Course Aims and Objectives

2.1.1 Flexibility of materials

One of the initial, intended goals of our courseware was that it can be used in a variety of courses, perhaps including undergraduate degree programmes in computer science, physics, all branches of engineering, mathematics and electronics, as well as the basis of training courses run by computer service departments. The challenge of designing learning materials for such a diverse group is to make the materials approachable for all classes of user, and yet maintain a high degree of specialism, for example, relevant to the field of parallel computing or computer vision.

Designing such materials confronts many well-established and accepted instructional design principles. The first step in many instructional design models is to analyse the learners who will use the materials. Analysis of even a subset of potential users, however, would have proved expensive and time-consuming. Therefore a compromise was made by putting effort into ensuring that the material would appeal to a broad audience.

2.1.2 The Use of Hypermedia and the World Wide Web (WWW)

There can be little doubt that the WWW has become the most successful networked multimedia hypertext based system in recent years. The *HTML* language[Cla94, Hug94] used in WWW documents is extremely simple and yet powerful to use[HMMSS94, HS94, Mar94, Mar95, MHMS+94]. These factors highly influenced our choice of hypermedia implementation systems.

However several severe restrictions in the current WWW protocol mean that more advanced *hypermedia* systems need developing.

2.2 Stage 2: Develop Necessary Learning Experiences

The materials originally designed at Cardiff were based on lecture notes from existing courses. The use of lecture materials is a logical foundation on which to build a course. On their own, however, lecture notes are insufficient. User activities during learning are more important in determining what is learned than the presentation of instructional material [MK93]. The aim of evaluating the original lecture notes was to convert them into more effective learning materials. To accomplish this, the initial lecture notes in HTML format were evaluated using models developed from principles of instructional theory. Evaluation was undertaken at an organisational level and instructional level. The organisational level focuses on courseware structure, by means of analysis of users and evaluation of the learning that has taken place. At the instructional level evaluation was concerned with the educational effectiveness of unit content.

Organisational Unit Design

We initially considered several Instructional Design models and eventually adopted an established instructional design model: the ASSURE Model developed by Heinich, Molinda and Russels[HMR93]:

A Analyse Learners
S State Objectives
S Select Media and Materials
U Utilise Media and Materials
R Require Learner Participation
E Evaluate and Revise

The use of the ASSURE model for initial evaluation allows for the systematic alteration of existing course material (lecture notes, *etc.*) by focusing on learning issues which might not have been addressed in the original lecture notes, such as the potentially diverse characteristics and experiences of users. For example, this led in many cases to the alteration of language to suit a more general audience.

Instructional Unit Design

The model described above is based on an iterative approach whereby the courseware developed is assessed and then revised. This may need to occur at the course unit level. The instructional level of evaluation is concerned with increasing the educational potential of each unit. This evaluation framework was adapted from Gagné's sequence of Instructional Events [GBW92], which are based on the hypothesised sequence of internal stages of information processing derived from studies of cognitive processes.

Utilisation of the ASSURE model and Gagné's Instructional Events is not intended to provide a prescriptive design model. Rather, it provides a framework based on sound instructional strategies within which it is possible for individual course designers to develop a dialogue about design strategies. The tools provide a common ground for collaboration. To illustrate the function of these tools in the development of educationally sound courseware, the implementation of each of the steps of the ASSURE Model will be discussed.

2.2.1 Analyse learners

As previously mentioned, it is expected that the users of the courseware will vary considerably in background and also in their purpose for using the courseware. This presents a problem in designing the courseware at the correct level of complexity, scope, *etc.* One factor affecting the model design is the anticipated implementation of the courseware. Will it be used independently of any lecturing, or in conjunction with lecturing courses, or even merely as a revision tool to support full lecturing courses? These are questions that cannot be fully answered at present, though it is probable that the courseware will be used in a variety of scenarios. It must be flexible enough to meet the various demands of the different implementations.

After evaluating the uses of the courseware it may be necessary to develop separate modules adapted to meet the various teaching environments, but which cover the same topics. At present, the courseware has been developed so as to be robust enough to stand as an independent teaching tool, with the aim that it will satisfy most of the demands made upon it. Lecturers may then be selective about the courseware material they use in their courses, adapting their courses as necessary.

2.2.2 State Objectives

Following on the assumption that the user is unfamiliar with the subjects presented, it is important that objectives are stated explicitly at appropriate levels of the courseware. This is done because the purposes of the courseware should be explained. This explanation should be part of the courseware design, particularly if it is to be used independently of lecturing.

Learners are informed specifically of what they should learn from the courseware. This approach increases their awareness of the key points in the notes, and hence increases the potential of the courseware to deliver the education required. Although each unit is prefaced by an introduction, the stating of objectives also serves as an advanced study organiser.

According to the model specification, a unit contains a list of objectives which relate to the unit as a whole, yet which can still be defined specifically. Each sub-topic within a unit also has a list of objectives which cover that particular sub-topic. Thus the stating of objectives reflects the hierarchical design of the model.

2.2.3 Select Media and Materials

The decision to use the WWW (and subsequent WWW browsers) as the medium for delivering the courseware was made at the commencement of the project. Consequently, the selection of media and materials has been less restrictive than conventional choices, due to the diversity of media formats supported by WWW browsers.

2.2.4 Utilise Media and Materials

The following mechanisms have been used in the development process: *(a)* Using MPEG Movies to Animate Algorithms; *(b)* Using Forms and Scripts to Achieve User Interaction; and *(c)* Using Java for true algorithm animation and user interaction.

2.2.5 Require Learner Participation

Hypermedia has been described as a more active learning medium than text because it forces learners to make decisions about which links to follow. This has been described by Romiszowski [Rom94] as a feed forward system: the user has control over which information nodes to view or ignore. This is a restricted form of interaction, however, which neither indicates nor ensures that the learner is processing the material at a deep cognitive level.

Each unit therefore includes exercises developed specifically to examine a range of learning objectives, from the testing of simple verbal knowledge, to more complex problem solving.

2.2.6 Evaluate and Revise

This step of the ASSURE Model is concerned with the evaluation and revision of the courseware to meet the constraints imposed by the implementation environment.

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2.3 Stage 3: Evaluate the Effectiveness of Learning

One of our concerns was how to evaluate the teaching materials. A traditional approach is to look at both the product - the materials that have been produced - and the procedure, *i.e.* how students learn from the material. The evaluation should seek to answer how well the objectives of instruction have been met, and what effects the use of the materials had on the learners. Such an evaluation is necessarily influenced by the way that the materials are implemented, so any evaluation of the materials must necessarily wait for field trials. What has been attempted is to develop general evaluation tools which will be included in each unit. They aim to address both organisational and instructional levels. One advantage of using HTML for this purpose is that it is possible to link evaluation forms to each module. The forms include Likert scales and spaces for comments.

To evaluate the effectiveness of the teaching materials, learners will be asked to rank their confidence for understanding a particular learning objective. Each learning objective for the unit will be stated, and confidence ranked accordingly. The feedback received from this data will allow designers to evaluate the effectiveness of the material at the level of the individual unit.

2.4 Stage 4: Improve the experiences in the light of evaluation

Improvement of the learning materials will depend partly on how they are implemented. Each of the scenarios that have been mentioned are potentially useful both educationally and financially. Undoubtedly, the material will need to be altered and adapted to suit the needs of particular students and subject domains. The evaluation tools that will be included with each unit will provide users of the material with some of the feedback needed to improve the experiences of learners. A detailed evaluation of the material, however, is possible only once the materials are in use and detailed field studies can be undertaken.

3 Parallel Computing Courseware

The material produced was developed with the aim of aiding the teaching of high performance computing throughout the university sector in the UK. The course consists of four *books*:

1. *A Classification Scheme for Parallel Computers.* This book describes Flynn's classification scheme for parallel computers.
2. *Interprocessor Communications.* This book describes two methods by individual processors within a parallel computer can send messages to other processors within the same machine.
3. *Load Balancing and Task Scheduling.* This book describes two methods by which an algorithm written for a parallel computer can achieve high efficiency by ensuring that all the processors are performing equal amounts of work.
4. *Parallel Algorithms.* This book describes the writing of algorithms for parallel computers.

To describe the essential features of the parallel computing courseware we will describe the book on Interprocessor Communications. Initially, after selecting this section from the four books mentioned above the user is presented with the page given in Figure 1.

This page (Figure 1) provides the following high-level information to the user:

- The top left area of the page outlines the contents of the book. This provides information not only on the titles of the book's chapters but also provides a means of directly accessing the chapters of interest (by clicking on its title) e.g. clicking on *Shared Memory* takes the user directly to this section in the book. The contents list also indicates the current position of the user in the book.
- In the bottom left part of the page, navigational aids are provided *(i)* to move around the information contained in particular books and *(ii)* to allow movement between different books. The various options are illustrated in Figure 2
- The right part of the page usually contains three subsections:
  - At the top the *Outline* section presents a very general and brief description of the topic under consideration, i.e. in this case interprocessor communication. The purpose of this is to allow the user to decide quickly whether the correct page has been accessed.

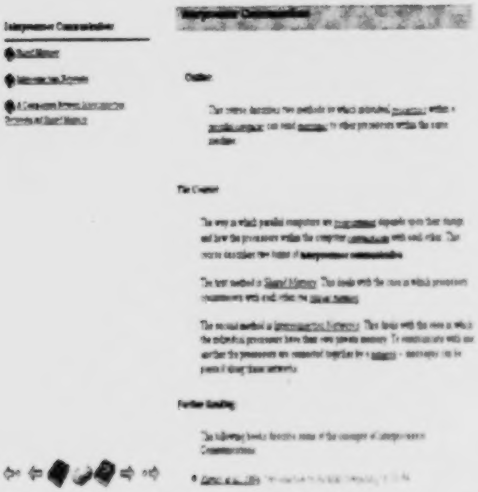

Figure 1: Interprocessor Communication Front Page

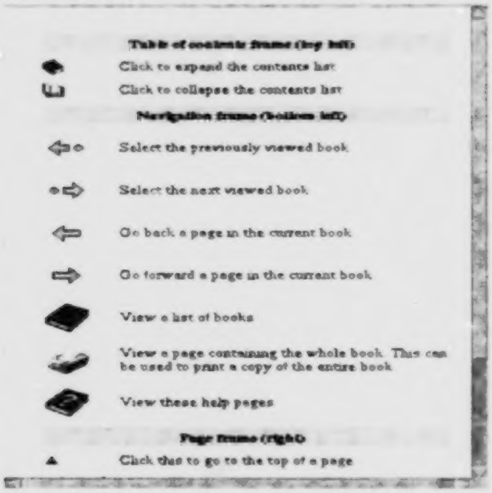

Table of contents frame (top left)

Click to expand the contents list

Click to collapse the contents list

Navigation frame (bottom left)

Select the previously viewed book

Select the next viewed book

Go back a page in the current book

Go forward a page in the current book

View a list of books

View a page containing the whole book. This can be used to print a copy of the entire book

View these help pages

Page frame (right)

▲ Click this to go to the top of a page

Figure 2: Navigational Options

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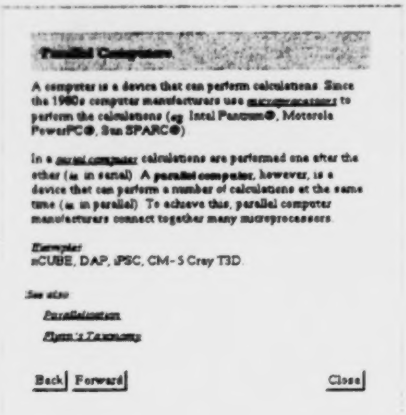
- The main part is the *Course* section. This gives a more detailed description of interprocessor communication (or whatever topic is under investigation) and includes links to relevant new topics such as Shared Memory and Interconnection Networks.

  Highlighted keywords in italics (and underlined), are links to background information which the user may need reminding of. For example, clicking on *parallel computing* gives a brief definition of parallel computing and is illustrated in Figure 3.



Parallel Computers

A computer is a device that can perform calculations. Since the 1980s computer manufacturers use microprocessors to perform the calculations (eg Intel Pentium®, Motorola PowerPC®, Sun SPARC®)

In a serial computer calculations are performed one after the other (ie in serial). A parallel computer, however, is a device that can perform a number of calculations at the same time (ie in parallel). To achieve this, parallel computer manufacturers connect together many microprocessors.

Examples:
nCUBE, DAP, iPSC, CM-5 Cray T3D

See also:
Parallelisation
Flynn's Taxonomy

Figure 3: Background Information: Parallel Computing

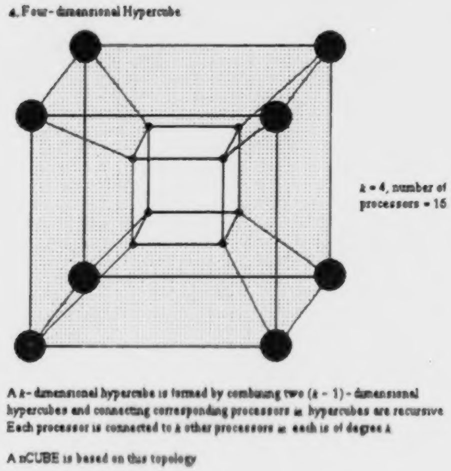
  Highlighted keywords or phrases that are not in italics are links to detailed information on the concepts under consideration, e.g. selecting *Interconnection Networks* would present the user with detailed information on their description, give examples, show mpeg movies etc. (e.g. Figure 4).
- The *Further Reading* section provides details of reference books (or articles), with page numbers, so that additional information can be obtained on the topic under consideration.

Overall, the courseware has been developed and constructed such that the user (i.e. student) is provided with concise relevant information and is not overwhelmed with too much detail per page. Navigational aids are constructed so that the students can search the complete course and individual books relatively easily. The general principles used in developing the parallel computing courseware can be applied to any subject areas.

4 C Programming

The basic design methodology of Section 2 has been extended in the following way for the C programming courseware [CM96, Mar95, MH96a, MH96b, MH96c, MHMS⁺94]:

- A form based key word search CGI was implemented.
- At the end of each chapter an exercises section was provided which adhered to the provision of exercises in the lecture course.
- Links for each exercise were provided to the Ceilidh automatic program marking systems ([ZF91]) to provide to the following :
  - Model solutions to exercises.
  - Interface to Ceilidh's automatic program marking module (Fig. 5).
- Links so that listings of programs can be obtained at relevant points in the notes.
- Interactive Java Applets to illustrate key data structure concepts (*e.g.* Linked Lists and Trees) have been implemented (Fig. 6).
- Links to alternative notes around the WWW.
- Links to local on-line information about using the workstation, C compilers, UNIX programming and on-line manuals.


a. Four-dimensional Hypercube
$k = 4$, number of processors = 16

A k-dimensional hypercube is formed by combining two $(k - 1)$-dimensional hypercubes and connecting corresponding processors ∴ hypercubes are recursive Each processor is connected to k other processors ∴ each is of degree k

A nCUBE is based on this topology

Figure 4: 4D Hypercube Description

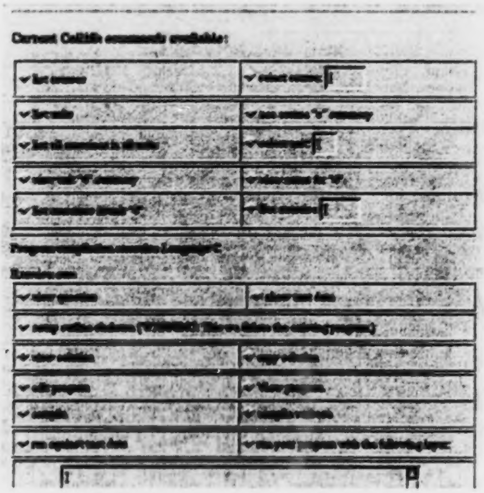


Figure 5: Program Assessment Interface

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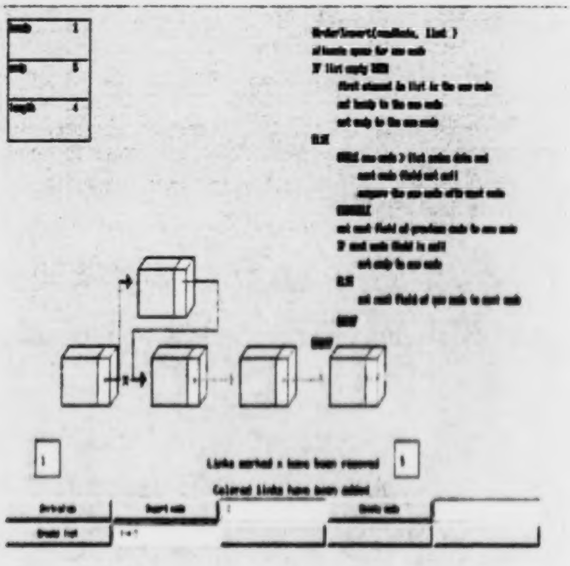

Figure 6: Linked List Java Applet

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Interaction by Electronic Mail in University Studies

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Abstract: A university course in which 31 undergraduate students practised academic argumentation in an e-mail study environment is described. In the two tutor-led 'e-mail study groups' the discussion themes were selected by the tutor while in the two student-led 'discussion groups' by the students.

The quantity and quality of student-student interaction was analysed. The results indicated that 42 % of the messages were interactive in nature including at least one reference to fellow students' messages. When difficult contents were addressed the tutor's guidance was found to be important in producing student interaction. From all the references (n = 259). 62 % expressed something else than taking of an attitude. 24 % agreement. 10 % grounded disagreement. and 4 % non-grounded disagreement. Grounded disagreement with fellow students turned out to be more common in the student-led groups while the students in the tutor-led groups expressed more often agreement.

Introduction

There is an increasing number of accounts of the use of electronic mail [e-mail] in elementary and secondary levels of education [Wells. 1993]. as well as in academic environments in which its appropriateness is widely recognized [Thomas. 1994]. The central reason for this is that the use of e-mail facilitates and increases interaction between participants and provides them with a collaborative learning environment. The positive learning effects of collaborative e-mail interaction have also been reported in several studies [for example Burge. 1994].

Characteristic of academic interaction is its argumentative nature. People possessing mature argumentation skills are able to present relevant and sufficient reasons for supporting their claims [Voss & Means. 1991; Marttunen. 1994] as well as to assess the strengths and weaknesses of different approaches and to present counterarguments. Perry [1981] emphasizes that argumentation plays a central role in developed scientific thinking since it includes the skill to provide evidence in support of one's opinions. Scientific thinking presupposes also a critical attitude towards knowledge. According to Byrne and Johnstone [1987], a critical attitude includes factors common with argumentation skills. such as objectivity. caution in drawing conclusions and weighting evidence. Hence. practising of argumentation can be regarded as essential in promoting the key objective of university teaching: teaching students the tools needed in scientific thinking.

To engage in interaction with other people has been found to be a successful way to practise argumentation and critical thinking [Smith. 1977]. Engaging in counterargumentation and debate has been especially emphasized as modes of interaction that promote students' learning of argumentation [Littlefield. 1995]. Since e-mail environments have been claimed to be appropriate in establishing interaction especially between students [Ruberg. Moore & Taylor. 1996] e-mail has been used in teaching informal argumentation and critical thinking [Charlton. 1993; Marttunen. in pressa. in pressb].

E-mail interaction has been previously studied by focusing on its amount [Ruberg. Moore & Taylor. 1996]. structure and contents [Friedman & McCullough. 1992]. and the interactive elements of e-mail messages [Henri. 1992]. However. students' cognitive processes during e-mail discussions have been studied much more seldom. although some such studies are available. The recent studies by Newman. Webb and Cochrane [1995] and Newman et al. [1996] revealed a deeper overall critical thinking ratio in the e-mail discussions compared to face-to-face discussions. In another study Ahern. Peck and Laycock [1992: see also Marttunen in pressb] found that in such an e-mail environment in which the students had more freedom to present their standpoints, most student-student interaction and argumentative discourse took place.

This study builds on these previous investigations on e-mail interaction by focusing on the quality and quantity of student-student interaction during a university course organized by e-mail. The questions addressed are: 1) How much student-student interaction did the students' e-mail messages include? 2) How argumentative was this interaction? 3) What kind of factors were associated with the quality and quantity of interaction?

Method

Subjects

The e-mail studies were carried out in connection of a M.Ed level introductory course in the sociology of education at the Department of Education at the University of Jyväskylä, Finland, during the autumn term 1990. The participants, 31 undergraduate students, were recruited to the experiment on a voluntary basis.

E-mail Study Arrangements

The studies were organized by using university's mainframe computer (Sun) and its electronic mail program (Elm) equipped with the text editor Emacs. A distribution list was attached to the e-mail system which made many-to-many communication between the students possible. The students could operate e-mail by using the terminals and personal computers located on-campus, or at home if they had a computer and a modem available.

Four e-mail study groups were established: two parallel groups engaged in the seminar mode and two parallel groups in the discussion mode of the e-mail study. Two top students near their graduation were also recruited as tutors to the studies. In the *seminar groups* the tutor selected the discussion topics and gave the students regular feedback. His role was to act as a teacher and a chairman of studies. In the *discussion groups*, by contrast, the students were allowed to select the discussion topics by themselves while the tutor acted, rather, as a co-learner and a facilitator of learning for the students.

During the six week e-mail studies the students were supposed to send from two to three messages a week in order to pass the course. Within each individual study group the messages were automatically delivered to all the group members and to the tutor through the distribution list.

In their e-mail messages the students were supposed to deal with the contents of the set books (Donald Broady: The Hidden Curriculum; Tuomas Takala (Ed.): Basics of Educational Sociology) and course lectures. Since the content of Broady's book was conceptually complicated and touched only slightly the students' life experiences it was classified as '*difficult*'. By contrast, since Takala's book delt with a wide range of such themes (e.g. 'gender and school', 'youth cultures', 'economy of education', 'social mobility') that the students were familiar with on the basis of their previous life experiences it was classified as '*easy*'. In the discussions the students practised argumentation by presenting in their texts their own grounded opinions on issues included in the course contents. The students were especially encouraged to engage in counterargumentation by presenting grounded critique towards the other students' arguments and by defending their own arguments when critiqued by others.

Data

The students wrote 489 e-mail messages during their studies. From these the messages relevant in terms of the study of the course contents were included in the data ($n = 441$). The 48 excluded messages dealt solely with technical matters and organization of the e-mail studies.

Interaction Analysis

The analyses of the students' messages concentrated on explicit student-student interaction by defining the references pointing to fellow students' messages sent earlier [see Henri, 1992]. The analyses proceeded through two phases. In *the first phase* the students' messages were classified into interactive and non-interactive messages (X1). An interactive message included at least one reference to a message sent by a fellow student earlier, and a non-interactive message did not include any such references. In addition, the messages that included responses to responses were defined as real-interactive messages [see Bretz, 1983], and the messages that did not include such references as non real-interactive messages. *The second phase* of the analysis concentrated on the nature of the references by classifying them into four categories: a) agreement, b) grounded disagreement, c) non-grounded disagreement, or d) non-relevant. The references expressing *'agreement'* indicated that the writer shared the opinion with the fellow student, while the references expressing disagreement indicated that the student was of the opposite opinion, either totally or partially, with the fellow student. The references in which the writer had grounded his/her disagreement were classified into the category *'grounded disagreement'*, and the references in which the counter-opinion was not supported with grounds to the category *'non-grounded disagreement'*. The content of the references classified into the category *'non-relevant'* was not relevant in terms of counterargumentation expressing something else than taking of an attitude. Such references expressed, for example, questions, answers to questions or appeals etc.

Statistical Analyses

Logit-models [Goodman, 1979] were used in determining factors associated with the quality and quantity of interaction in the messages. Five separate Logit-analyses were carried out. The dependent variable varied in the different analyses while the independent variables were the same. Each of the dependent variables divided the messages into two categories on the basis whether the property in question appeared (value 1) in the message or not (value 0). The dependent variables were '*Interactivity of the message*' (X1), '*Occurrence of references indicating agreement*' (X2), '*Occurrence of references indicating grounded disagreement*' (X3), '*Occurrence of references indicating non-grounded disagreement*' (X4), and '*Occurrence of non-relevant references*' (X5). The Independent variables were '*Mode of the e-mail study*' (X6, tutor-led vs student-led), '*Gender*' (X7, male vs female), and '*Book*' (X8, difficult vs easy).

The analyses indicated that the independent variable 'Mode of the e-mail study' (X6) had a statistically significant main effect with the dependent variables 'Agreement' (X2) and 'Grounded disagreement' (X3). In addition, variables 'Mode of the e-mail study' (X6) and 'Book' (X8) had a statistically significant interaction effect with the dependent variables' Interactivity' (X1) and 'Non-relevant' (X5). The independent variables 'Mode of the e-mail study' (X6) and 'Gender' (X7) had, as well, a statistically significant interaction effect with the variable 'Interactivity' (X1) while none of the independent variables employed in the analyses was associated with the dependent variable 'Non-grounded disagreement' (X4).

Results

Quantity of the E-mail Interaction

According to the results, 42 % of the messages were interactive in nature including at least one reference to a message sent by a fellow student earlier. In addition, 6 % of all the messages included real interaction [Bretz, 1983] indicating that a student had responded back to a fellow student's response to his/her original statement.

Furthermore, although the amount of interactive messages was quite low, the results showed that all of the e-mail students (n = 31) engaged in interaction: two (6 %) of the students referred twice to a fellow student's message, seven (23 %) three times, and 22 (71 %) four times or more.

The results of the Logit-analyses indicated that the variables 'Mode of the e-mail study' (X6), 'Gender' (X7), and 'Book' (X8) affected the interactivity of the messages. Table 1 illustrates the effects of these variables.

Table 1: Differences in the interactivity of the messages by the mode of the e-mail study

	Mode of the e-mail study					
	Seminar		Discussion		Total	
Interactivity of the message	f	(%)	f	(%)	f	(%)
Messages concerning difficult contents (Broady's book, n = 150)						
Interactive	44	(52)	16	(24)	60	(40)
Non-interactive	40	(48)	50	(76)	90	(60)
Total	84	(100)	66	(100)	150	(100)
Messages sent by female students (n = 204)						
Interactive	56	(49)	26	(29)	82	(46)
Non-interactive	59	(51)	63	(71)	122	(54)
Total	115	(100)	89	(100)	204	(100)

According to the results [Tab. 1], the messages concerning difficult contents were more often interactive in the seminar groups (52 %) than in the discussion groups (24 %). The results indicated also that female students sent more interactive messages in the seminar groups (49 %) than in the discussion groups (29 %).

Quality of the E-mail Interaction

The results concerning the nature of the references (n = 259) indicated that 62 % of the students' references to fellow students' messages were non-relevant in terms of argumentation expressing something else than taking of an attitude. In addition, 24 % of the references expressed agreement, 10 % grounded disagreement, and 4 % non-grounded disagreement.

The results of the Logit-analyses revealed that the variables 'Mode of the e-mail study' (X6), and 'Book' (X8) explained the appearance of different kinds of references in the students' messages. Table 2 clarifies the associations between these variables.

Table 2: Differences in the presence of different kinds of references in the student's messages by the mode of the e-mail study

	Mode of the e-mail study					
	Seminar		Discussion		Total	
Variable	f	(%)	f	(%)	f	(%)
Agreement (X2, n = 320)						
Yes	31	(17)	9	(6)	40	(12)
No	147	(83)	133	(94)	280	(88)
Total	178	(100)	142	(100)	320	(100)
Grounded disagreement (X3, n = 320)						
Yes	4	(2)	14	(10)	18	(6)
No	174	(98)	128	(90)	302	(94)
Total	178	(100)	142	(100)	320	(100)
Non-relevant (X5, n = 150)*						
Yes	31	(37)	9	(14)	40	(27)
No	53	(63)	57	(86)	110	(73)
Total	84	(100)	66	(100)	150	(100)

* Messages concerning difficult contents

The results indicated [Tab. 2] that the students in the seminar groups produced more often messages including references that indicated agreement with their fellow students than did the students in the discussion groups (17 % vs 16 %). By contrast, the students in the discussion groups sent more often messages in which they referred to their fellow students in a way that indicated grounded disagreement (10 % vs 2 %). The results indicated also that when the messages concerned difficult contents the students in the seminar groups sent more often messages that included such references to their fellow students that were not relevant in terms of argumentation (37 % vs 14 %).

Discussion

The results showed that a majority of the students' e-mail messages were non-interactive in nature. This result suggests that although the pedagogical aim of the e-mail studies was to engage the students in interaction this aim was not realized very well. However, despite the low proportion of interactive messages, all of the e-mail students did engage in interaction by referring to a fellow student's message at least twice. Thus, it can be said that the e-mail study, to a certain extent, supported the students' engagement in interaction. Similar findings have also been reported by Ruberg, Moore & Taylor, [1996] who found that the use of e-mail increased student-student interaction in particular. The results of this study are especially important in the context of Finnish higher education in which one of the major problems is the lack of student-student interaction and the scarcity of study methods based on critical discussion of issues. The results namely suggest that interaction between students in higher education studies can be created by using e-mail. Furthermore, in the light of previous study results [Zirkin & Sumler, 1995], the results in this study suggest that the use of e-mail promotes student's learning as well. In their summary of literature on studies on interaction Zirkin and Sumler report findings indicating that the more interactive the learning environment was the more favourably the instruction was perceived and the more effective the learning outcome was likely to be.

The results indicated also that the mode of the e-mail study along with the nature of the contents and gender proved factors associated with the interactivity of the messages: when the discussions were based on difficult contents (Broady's book) the tutor-led seminar mode produced more student interaction, although non-relevant in terms of argumentation, than did the student-led discussion mode. In addition, the results showed that the female students engaged in the seminar mode produced more interaction that those who were engaged in the discussion mode. These results suggest, *first*, that when the e-mail discussions are based on difficult contents the directive role of the tutor is important in order to get the students discuss matters and exchange opinions. However, when the students discuss easy contents the tutor's role seems to be less important in terms of producing interaction between students. *Second*, the results suggest that the directive role of the tutor increases the amount of interaction produced by women while men seem less prone to react to variations in the tutor's activities.

Furthermore, according to the results the interaction between the students was mainly non-argumentative in nature: only 14 % of the students' references to each others' texts expressed an opposite opinion with a fellow student. When interpreting this result it is important to take into account the study of Terenzini et al. [1995] according to which attending the intellectual atmosphere of college and university studies promotes the development of argumentation and critical thinking skills. Since most of the e-mail students in this study had only a short-term study experience the result indicating a small amount of argumentative references becomes more understandable.

The results revealed also that grounded disagreement with fellow students was more common in the discussion groups while the students in the seminar groups expressed more often agreement. This result indicates that when the students' self-directive learning was supported by providing them with the possibility to select the discussion topics by themselves, grounded counterargumentation was most likely to come about. Ahern et al. [1992] also reported findings that supported the favourability of self-directive e-mail study when aiming at producing student interaction. Hence, the study suggests that providing the students with freedom to direct their studies can be regarded as a beneficial and sensible way to organize students' working in an e-mail environment, especially when aiming at practising academic argumentation.

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A New Arrival: Health Sciences Education "Delivered" Over the Internet

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Abstract: The Educational Technology Laboratory at the Medical University of South Carolina (MUSC) has developed a model Internet site to demonstrate ways in which interactive instruction can be provided over the Internet. An ad hoc committee composed of volunteer faculty members provided assistance, insight, and evaluation during the development of the site. Throughout the process, the development team focused on student learning, rather than the technology of the Internet. During demonstrations of the site, the audience was encouraged to think about the same issues the development team considered during production: What do students need to learn? What are effective methods and strategies for learning? Can there be a match between what students need to learn, the methods and strategies for learning, and the capabilities of the Internet? How could use of the Internet as an instructional tool change the role of a teacher? As a result of these demonstrations, faculty members are working with the Educational Technology Laboratory to develop interactive Internet sites designed for learning.

"At the Medical University of South Carolina, the University's academic programs are designed to...emphasize the development of critical thinking abilities, encourage curiosity, and instill a desire for lifelong learning." [Owens, 1996]

"The Internet provides a new medium for reaching out to find knowledge and meaning." [Negroponte, 1995]

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- All over the United States, vinyl records are stored away in boxes collecting dust because people recognized the advantages of the CD, including its improved sound quality and durability
- Portable phones are popular due to their compatibility with our mobile lifestyles
- Microwave ovens have been readily accepted not only for their speed but their ease of use, as well.
- A reduction in a monthly utility bill makes it easy to observe the advantages of installing the latest "high tech" double insulated windows
- Following a trial period, a large school district quickly adopted a policy that provided schools the option of requiring students to wear uniforms [Charleston County School District, 1996]

Rogers [1993] reports that an innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. According to this definition, CDs, microwave ovens, portable phones, insulated windows, and the concept of public school uniforms were at one time considered innovations; so is the Internet. Why are some innovations adopted while others are not? What makes the difference? Will use of the Internet as an instructional tool be seen as an innovation worthy of adoption, or will it start with a bang and quickly fade away? It is an innovation's relative advantage, compatibility, complexity, observability, and/or trialability, that are the major factors that determine its adoptability [Rogers, 1993]. Therefore, can the Internet be shown to have advantages over other instructional tools? Is it compatible with instructional methods that already exist? Is it complex to use and/or maintain? Can it be given and/or taken in "small doses" (e.g., "trial periods")? Are results of its use easy to observe?

Perhaps focusing on what it is we want students to LEARN rather than the TECHNOLOGY of the Internet will provide educators with the opportunity to recognize the instructional potential of the Internet, and that the Internet is an innovation worthy of adoption. According to Reeves [1996], the effectiveness of learning on the Internet is a function of the skills and experience learners have with it and the degree to which curricula and Internet sites have been designed to support sound pedagogical dimensions. Therefore, before exploring the use of the Internet as an instructional tool, it is important to focus on some of the key aspects of learning and effective teaching strategies, such as those outlined by Laurillard [1993]:

Apprehending Structure - Students construct meaning as they read, listen, act and reflect on the subject content. However, as Laurillard [1993] points out, "Meaning is given through structure" [p. 51], and it is therefore essential that students are able to interpret the structure of any discourse before they can construct meaning that is crucial to understanding. Students adopting a surface approach to learning would fail to do this, as they focus on memorizing a number of phrases and points or later reproduction.

Integrating Parts - Students need to be able to integrate the signs of knowledge such as language, symbols, and diagrams with what is signified by them.

Acting on the World - There are few teachers who attempt to teach without asking students to do something, whether it be laboratory sessions or essay writing. Students are asked to engage in some form of activity which, when integrated with other activities, assist in understanding of content.

Using Feedback - Actions such as those mentioned above are futile for student learning, unless feedback on individual action is available.

Reflecting on Goals-Action-Feedback - Learners interpret and understand reality as they make links between each of the above aspects by reflecting on the goals of learning, actions taken, and the results of those actions.

The challenge for educational developers is to use this knowledge of learning together with an understanding of the features of the Internet, to design learning

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experiences which promote a deep approach to learning, so that "what" students learn is a deep understanding of the subject content, the ability to analyze and synthesize data and information, and the development of creative thinking and good communication skills [Alexander, 1995].

Many of these aspects of learning are reflected in a portion of the Medical University of South Carolina's educational philosophy:

> "At the Medical University of South Carolina, the University's academic programs are designed to ...emphasize the development of critical thinking abilities, encourage curiosity, and instill a desire for lifelong learning. Learning is viewed as an active, dynamic process for which students and faculty share responsibility...The educational experiences of all University students are designed to incorporate opportunities for interdisciplinary dialogue and collaboration in classroom, clinical, and social settings. To meet better the educational needs of our students and the health care needs of South Carolinians, clinical learning experiences occur in community-based and primary care sites, as well as the more traditional tertiary and specialty care settings." [Owens, 1996]

As the Medical University of South Carolina strives to implement this educational philosophy, it is also attempting to address the same issues faced by other institutions of higher education:

- due to students' schedules and needs, requests are being made for classes delivered over the Internet, allowing "anytime, anywhere access"
- distance education courses and degree programs are reaching students all over the country, providing competition among schools for enrollment
- on-line courses, degree programs, and the use of technology appear to be marketing strategies and without them, a school may be considered "behind the times"

In light of these factors, the Educational Technology Laboratory at the Medical University of South Carolina developed a model Internet site to demonstrate to the administration and faculty possible ways in which the Internet, when used as an instructional tool, could address some of these issues. At the same time, the Educational Technology Laboratory also recognized that providing on-line courses would require more than one or two faculty members developing several web pages. In fact, it could be argued that individual faculty members can conduct individual experiments that point the way to systemic change, but they cannot make significant, systemic changes by themselves. Higher education needs to begin with a clear vision of what it is they are trying to accomplish in the field of technology-mediated learning. Too often, discussions about the integration of technology and instruction begin with the question, "Why hasn't it worked?" This is usually followed by, "How can we get them to use it?" Technology is an enabling mechanism; it is not an end in itself.

Therefore, the first decision made in planning for the development of this model Internet site was to enlist as much support as possible on a campus-wide basis. The University Education Committee (UEC) was the logical place to garner support since it is composed of representatives from all of the colleges on campus (e.g., nursing, pharmacy, medicine, dental medicine, health professions, etc.). This committee's charge is to support the University's educational philosophy and develop guiding principles on issues such as distance education and technology-mediated learning. The proposed design of the model Internet site supported the University's educational philosophy and the UEC's goals for distance education. Therefore, the Educational Technology Laboratory approached the UEC for support of the proposed project, in turn receiving a statement of commitment and support, as well as a small grant.

The model Internet site developed by the Educational Technology Laboratory is designed to:

- assist administrators and faculty in further clarifying what the Medical University of South Carolina is trying to accomplish in the area of technology-mediated learning
- demonstrate ways in which the Internet can enable students to become the kind of learners referred to in the University's educational philosophy: critical thinkers, curious, and possessing a desire for learning

After obtaining the endorsement of the University Education Committee for development of this site, the Educational Technology Laboratory asked for faculty volunteers to form an advisory ad hoc committee. Fifteen faculty members volunteered. The purpose of this ad hoc committee was to provide a forum for discussing issues that needed to be taken into consideration through the development process (e.g., design issues, instructional needs, student connectivity, and administrative needs). The ad hoc committee's suggestions were incorporated throughout the process. Their participation also provided an initial basis of support for this project among the administration and faculty.

The model Internet site is divided into three areas: resources, communication, and content. These three areas are integrated into a single HTML page with all of the features of the program accessed from one page (e.g., e-mail, chat lines, video conferencing, etc.). The resources section provides access to assignments, a class syllabus, and a link to the library's databases. These resources assist students in understanding the structure of the course content so that a base of information is provided upon which to build comprehension and understanding. In order to demonstrate ease of use, a password secure area allows a faculty member to update or change assignments from their own computer. The communication section provides an opportunity for students and faculty to easily send, receive, and check e-mail, join class list serves, and participate in live "chat" sessions or video conferences. Through increased access to faculty, useful resources can be shared and problems solved jointly. In addition, these communication technologies allow students and faculty to exchange work more thoughtfully and "safely" than when confronting each other in a class or faculty office. The model site also illustrates possible uses of interactivity over the Internet. For example, students can label a medical illustration and complete an evaluation receiving immediate feedback, including a score and the correct answers. Students also have the opportunity to share their ideas and respond to others through group discussion questions related to the "real world". Chickering and Ehrmann [1996] state that sharing ideas and responding to others' improves thinking and deepens understanding; students must also talk about what they are learning, write reflectively about it, relate it to past experiences, and apply it to their daily lives. The discussion questions on the model site provide this opportunity. In addition, all of the activities and teaching strategies incorporated into the model site give students an opportunity to employ the key learning aspects identified by Laurillard [1993]: apprehending structure, integrating parts, acting on the world, using feedback, and reflecting on goals-action-feedback.

Demonstrations of the Internet site have been made to faculty and administrators, first emphasizing the use of the Internet as an instructional tool. Secondly, these demonstrations have addressed instruction over the Internet as an innovation and how characteristics of an innovation may encourage adoption: its advantages over other forms of instructional tools, its compatibility with current instruction, lifestyles and student needs, its lack of complexity and opportunities for trialability [Rogers, 1993]. In each demonstration, the audience was encouraged to think about what they wanted students to learn and whether or not the appropriate instructional methods and strategies could be provided over the Internet. Demonstrations also provided examples of ways in which course delivery over the Internet could influence teaching styles, thereby providing greater opportunities to change from a lecturer to a mentor and guide. Other issues discussed during demonstrations included student acceptance of instruction over the Internet, and the "nuts and bolts" that needed to be taken into consideration prior to the development of an on-line course.

As a result of this model site, the Educational Technology Laboratory is working with various faculty members in the design and production of courses or portions of courses that will be delivered over the Internet. The Educational Technology Laboratory believes that the Internet can be considered a new media teaching tool. Internet developers can benefit from the wealth of related research, the way people learn the strategies that promote the kind of learning we value, and the lessons learned by earlier technology developers. If we use this knowledge, students of today can look forward to ever increasing ways in which this technology can assist them in becoming lifelong learners.

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Necessary Ingredients of Integrated Network Based Learning Environments

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Abstract: In this paper we present for the first time to a wide public the MANKIND project: MANKIND is an acronym for *M*ultimedia *A*nd *N*etworked *K*nowledge-transfer *I*ntroduces *N*ew *D*imensions. It is an ambitious undertaking that combines know-how obtained through extensive research and efforts in network based training and education with work on digital libraries and the development of the advanced WWW server system Hyperwave (formerly called Hyper-G).

It is our belief that CAI (Computer Assisted Instruction), CBT (Computer Based Training), ITS (Intelligent Tutoring Systems), WBT (Web Based Training) and similar efforts that have tried to support teaching and learning through (networked) computers have generally failed and will continue to do so, unless an integrated approach is taken, i.e. unless all necessary ingredients are taken care of. The MANKIND project is probably one of the first such integrated efforts. Parts of it are operational and indeed in use (e.g. for distributed training for MOTOROLA employees world-wide, as teaching support at the Graz University of Technology or at Queens University [Skillicorn 1996], or as teaching and lecturing support system at the University of Freiburg [Bacher et al 1996]); other parts are under development and yet others still in the planning stage. This paper is a summary of the main points that are being tackled by MANKIND. Any other system, existing, under implementation or being planned should be measured by how well it matches the „ten guidelines for MANKIND" outlined in the main section 2 of this paper.

1. Introduction

The history of efforts to use computers for educational purposes is over 35 years old and is (overall) a history of failures. An analysis why this is so, and why - nevertheless - new waves of efforts have started every few years (and we are witnessing another Web-based wave right now) is contained in chapter 1 of [Maurer et al 1996] and will not be repeated here.

Let it be sufficient to say that all attempts, so far, have had serious deficiencies one way of another. Some of them due to technical reasons, some due to the lack of pedagogical theories, most of them through a combination of both and the fact that no system has provided enough flexibility. None has provided a rich enough variety of learning and teaching models allowing it to be tailored towards specific subject areas and particularly towards individual student knowledge acquisition techniques.

The MANKIND project it not trying to follow a particular cognitive paradigm. Rather, it tries to provide facilities that allow the incorporation of very diverse models of knowledge-transfer. Its success will be measured by how flexible educators and students will find the system for the adoption to their needs.

The main section of this paper, section 2, contains the „Ten guidelines for MANKIND" that we consider necessary ingredients of any integrated network based learning environment. The aim of the MANKIND project is to create an environment satisfying the ten guidelines; it is based on the currently most advanced WWW server system Hyperwave (see e.g. http://www.hyperwave.com and references mentioned later). The

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guidelines have been derived from much research and concrete experiments starting with COSTOC (e.g. [Makedon et al 1987], [Huber et al 1987], [Huber et al 1989], [Gillard et al 1990], [Maurer et al 1990], to HM-Card (e.g. [Maurer et al 1995a], [Maurer et al 1996], from work in digital libraries (e.g. [Maurer et al 1994], [Marchionini 1995], [Maurer et al 1995 b], [Lennon et al 1995a]) to the development of the advanced WWW - server systems Hyperwave (formerly Hyper-G) e.g. [Kappe et al 1993], [Kappe et al 1994], [Fenn et al 1994], [Andrews et al 1995a], [Andrews et al 1995b], [Andrews et al 1995c], [Maurer 1996a], and taking into account recent related work such as [Mühlhäuser 1995], [Adam et al 1995], etc.

In section 3 we will review which of the guidelines to be described have already been implemented based on Hyperwave and what the situation is like concerning the remaining ones.

2. The ten guidelines for MANKIND

In this section we present ten general theses (guidelines) that must be kept in mind when designing or evaluating an integrated teaching and learning environment. Some of them have already been analysed in more detail in LATE (see [Maurer 1996b]) which provides goo background reading. Note that the ten theses presented are also seen as the basic guidelines for project MANKIND mentioned earlier.

Thesis 1: No matter what technology is used, insights obtained for traditional courseware design both from a pedagogical and content/form point of view must not be ignored.
It is amazing to see that in current multimedia efforts based on HTML (WWW) pages, HyperCard or Macromedia derivatives and the like many of the lessons learnt (see e.g. [Kearsley 1982], [Nievergelt 1980]) on courseware design are completely neglected. Too many persons seem to believe that linking a few HTML pages together produces viable material for teaching and/or learning purposes. Whenever a substantial piece of courseware is designed it is e.g. essential that aims and prerequisites are clearly stated, that the material is well motivated, that features technically available like fonts, colour, graphics, animations, etc. are not used as gadgetry but only when helping to understand the issues to be communicated; that student interaction beyond „electronic page turning" is essential and can often be achieved using checkpoints with feedback, built-in simulation, guided tours of material presented in one window, a second window used for guidance; that the level of the material is sufficiently concrete (e.g. through the use of examples); that the tone is personal yet not condescending, etc., etc. We refer to the literature mentioned, including chapter 6 of [Maurer 1996] for more details. However, we want to point out that most technologies allowing the creation of courseware permit the creation of both well-done and unsuitable material. They usually do not provide „built-in guidance" to avoid at least some of the most glaring pitfalls. We consider this an important area of work, yet an area not directly addressed in MANKIND that (see below) takes an open view as far as „authoring tools" are concerned.

Thesis 2: The production of high-quality courseware has to be made as easy as possible.
In a system like MANKIND this means basically four things. First, the system has to be open to let authors choose their preferred tools; second, techniques such as „authoring on the fly" (a term first coined in [Maurer 1994] and successfully pursued by the group of Thomas Ottmann at Freiburg (see [Bacher et al 1996] for a concrete implementation and [Lennon et al 1995b], [Lennon et al 1994] for background ideas) has to be supported as much as possible; third, statistical information and feed back from students has to be provided by the system for the improvement of materials; and fourth, courseware has to be designed in a modular way so that it is easy to update and reuse.

It is the last issue that is maybe the most important yet often overlooked aspect. It is one of the many reasons why ordinary WWW where all the structure is built into the links cannot be seen as serious candidate for sophisticated MANKIND-like systems. A more powerful WWW system such as Hyperwave [Maurer 1996] is needed to be able to structure the material into modules (called „collections“ in Hyperwave) that can be reused and updated without the need to change any links to and from them. The HM-Data model [Maurer et al 1995a] is another step in the same direction and so is HOME (see [Duval et al 1995]). It is of extreme importance that we understand that in WWW we have to replace links by structure as much as possible in the same way as we have learnt that it is essential to use structure in programs (rather than goto's) and structure in handling data (rather than employing explicit pointers). Any person not realising that embedded links used for structuring purposes must not be used in sophisticated multimedia networked educational environments is well advised to consult the literature to fully understand the implications of what has been hinted at above.

Thesis 3: We need guidance but not dictatorship.
Early CAI/CBT systems were often suffering form the „tunnel syndrome“. When working through material you felt „locked in“, scarcely able to leave a predefined route, let alone look up electronic background material, have an electronic chat with others, etc.

The advent of hypertext/hypermedia (and WWW) turned this all 180 degrees around. Suddenly, there was unlimited freedom, a spaghetti-bowl of links to be followed, the „tunnel syndrome“ suddenly replaced by „lost in hyperspace“. Neither for teaching nor self-studies (and we return to those two separate aspects of the use of networked multimedia material in Thesis 10) do we want either of the above phenomena. For MANKIND this means three things: first, a certain amount of guidance through the material to be learnt is provided; second, at each moment in time control on where to continue rests with you, not the system; third, throughout the knowledge acquisition process the „guided path“ can be left in favour of many other activities (see Thesis 2 through Thesis 7), but in particular can be left to consult an electronic library residing in the background. Such electronic background libraries may range from a small selection of dictionaries, books, supporting multimedia material and software to very large electronic archives covering all kinds of knowledge. To be able to work efficiently, this knowledge again must be structured, and „search scopes“ depending on your personal profile must be definable, else the typical information overkill your experience with search engines on the Web is unavoidable. To fully exploit both the associative aspects of linking information and the search facilities and structure delivered by database systems, WWW systems with built-in databases are the most suitable solution for the issues mentioned, one other reason why Hyperwave was chosen as basis of MANKIND.

Thesis 4: Facilities for annotations are essential.
As you are working through some material, whether it is courseware in the classical sense, an electronic book, a library of pictures or what have you, you must have the possibility to add personal notes. Such personal notes could be text, pictures, arbitrary documents or even links to other material: how often has it happened to you that you found a piece of information x that you wanted to link to information y so that on revisiting x you would find your note and the link to y but you could not do so: after all, in ordinary WWW systems you cannot add links to documents that don't belong to you. In MANKIND - since it is based on Hyperwave - you can. And your notes (or links) are visible only to you, a group you define, or the general public, just as you decide.

Thus, annotations not only permit you to add notes as if „writing into the margins of a book“, they allow you some customisation (personalisation), a crucial issue that is the central point of Thesis 10.

Thesis 5: Facilities for asynchronous computer conferencing are imperative.
As important as it is to be able to take notes and attach them wherever suitable, it is still more important that others can read your notes, can comment them (i.e. attach their notes to yours), etc. Thus a general annotation concept as described in Thesis 4 actually leads automatically to the important tool of asynchronous computer conferences (ACC's).

ACC’s in their most simple version are like newsgroups or bulletin boards. However, often a better structure (to be able to follow the thread of a discussion) is preferable, even to the extent of supporting such „networks of annotations“ by tools that display a topic as icon and graphically show how many comments in any of a number of user defined categories („supporting example“, „counter example“, „supporting argument“, „counter argument“, „generalisation“, „special case“, „answer“, „related idea“, etc.) exist, what reactions those comments have provoked, and so forth. Note that annotations can be attached to a whole file (like a HTML page), or just to a particular part of text; they may be textual, but audio or video comments are equally conceivable: Observe further that one and the same document should be able to show a completely different set of annotations, i.e. different ACC’s, depending on the group of users accessing the document. MANKIND type systems will usually require some kind of identification (see [Flinn et al 1995]) to be able to distinguish various ACC’s. It is also desirable to combine ACC’s with mail systems. A minimal solution is to inform members of an ACC by email that new contributions have been added to the ACC. Observe that ACC’s are a natural extension of (semi-public) annotations and can be a major factor in any teaching and learning environment. It is often desirable to have „moderated“ ACC’s to avoid the possibilities of „disintegration“ of ACC’s that is sometimes observable. In passing we observe that ACC’s that are structured as a three-dimensional world you can walk around in to choose what interests you offer further new and attractive alternatives.

Thesis 6: Question/Answer dialogues should be possible where users need them.
In traditional CAI/CBT systems authors of courseware usually attempted to predict locations in the material that would require further elaboration (and would offer additional information if you decided you need help); or they tried to determine if you needed help by „asking questions“ and reacting to the answers received.

This „static model“ of question/answer dialogues is replaced in MANKIND by a much more dynamic approach. First, the system may ask you questions in the traditional sense, mainly for self-test and selection of material purposes as explained under Theses 9 and 10; secondly, and much more important, you as user can ask a question at any point as a kind of annotation: it may be a question to fellow students or to a tutor or teacher; and you may get immediate feedback if one of the persons addressed is currently on-line (e.g. if you ask a question during the official „electronic office hours“ of a tutor). Observe that the „technology“ for asking and answering questions may vary from text-only, to audio, video, or even 3 D, and may be affected by bandwidth, available hardware, etc. Thus, a general system should allow a „graceful“ degradation where necessary.

Thesis 7: An integrated teaching and learning environment needs synchronous communication facilities.
The possibilities alluded to in Theses 5 and 6 might leave the impression that no further communicative features are required. However, numerous experiments have shown that additional functions are required.

First, there is the need for „chatting“, where short individual contributions are not treated as separate documents but rather as one dynamically growing (and potentially non-persistent) document. Chats tend to degenerate often, particularly if there are more than a few participants. For this reason it is important to be able to initiate chats only with persons interested in similar topics. Typically, if you work through some chemistry material you may want to chat with fellow chemists, but not with persons currently working on Chinese literature. To be able to narrow down the set of persons potentially interested in a chat it is thus necessary to have the material in a MANKIND system systematically structured, as is e.g. possible using Hyperwave.

Secondly, chats alone are not enough. Of paramount importance is the availability of an electronic workspace (often in the form of a so-called whiteboard but in future also more and more in the form of 3D worlds populated by „avatars“ presenting other persons present) that can be shared by a number of users. Typical applications include a „follow me“ mode where one person leads others through some WWW pages, software package, etc., with „conversations“ between the participating persons going on at the same time. Such a workspace can also be used for co-operative work (on a piece of text, at graphic design in a 3D scene, or whatever) and is particularly useful for explanatory purposes: a question concerning a particular document can be answered and discussed in detail while this document is visible to all involved.

The „ideal whiteboard“ is open to all applications. I.e. you can run an arbitrary application in your whiteboard and whatever you do/see is visible to the group sharing the whiteboard with you. Unless the contents of the whiteboard is transmitted as a movie (e.g. 25 pixel images per second) whiteboards will only handle a certain set of applications. It might be worth mentioning that the whiteboard under development for MANKIND will e.g. support most of the HM-Card [Maurer et al 1996] functionality, including animation editing and question/answer dialogues, and 3D version are likely to be added, later.

Another important way of synchronous collaboration is found in so-called „decision room scenarios“. Typically, a topic is discussed in a strictly anonymous fashion (to overcome otherwise inherent fears of voicing unpopular opinions). Sometimes this is just done for „brainstorming“ purposes, sometimes the result may be an anonymous vote on how to proceed in a certain matter.

Thesis 8: Question/Answer dialogues should become part of the multimedia database.
As has been explained in theses 6 and 7 there are various ways how questions can be asked in a MANKIND system, and how and by whom they can be answered. While some of the dialogues (e.g. in the chat mode) might well be considered volatile (transitory) other question/answer dialogues should be archived for future use.

Typically, if a student asks a specific question and a tutor answers it, this question/answer pair should be recorded so that when other students ask a similar question later the system automatically can present the answer that might well have been given months ago! Clearly, if such a mechanism can be implemented, whatever material is at issue it will eventually be enriched by „all possible“ questions and answers to them. The difficulty clearly is how the system can recognise that question x is similar to question y. This is (almost) impossible even if x and y are text-only questions, and becomes still more intractable when x and y are formulated using spoken language. However, it has been argued in [Maurer 1996b] that by using the user's rather than the system's intelligence many of the problems can indeed be solved. Observe further that a piece of explanation that is soliciting many questions should probably be replaced by a better explanation, anyway!

Thesis 9: Testing and checkpoints are important.
It is, of course, conceivable that a system like MANKIND is enriched by a database of questions and answers and thus can also be used for examination purposes. To discuss the problems involved in this (e.g. from security to how the system evaluates whether a given answer is correct for questions that require more than the selection of a choice or the calculation of set of numbers) goes beyond the scope of this paper.

Note, however, that testing and checkpoints can and should be used for a variety of other purposes.

First, a pre-test can lead to selecting the proper set of „teaching modules“ in the right order (we return to this in Thesis 10). Second, material for self-testing is important for both material repetition (and hence retention) but also as indication to the users how much and deeply they have understood what has been discussed. Third, exercises - even very complex ones - are of high pedagogical value even if (as would usually be the case) the system itself cannot judge the quality of results: the system may present a number of good approaches, plus a number of bad ones - and leave further judgement to the user; the results may be checked (asynchronously or synchronously) by a tutor, or by fellow students, and students of tutors may even decide to incorporate good approaches permanently into the system. This leads to a fourth aspect, the aspect of voting and of „anonymous discussions“ much as mentioned in decision room scenarios at the end of Thesis 7.

Thesis 10: MANKIND cannot live without customisation.
The MANKIND ideas so far described present a fairly general and flexible integrated networked teaching and learning environment:

On the basis of existing modules new „courseware" is built rapidly and with high quality; you can peruse it at your own speed, and under your complete control; you can browse in background libraries, add notes for yourself and others, participate in discussions and votes, ask questions to fellow learners or tutors; and, in doing so, you increase the knowledge in the database and you provide important feedback; conversely, the system asks you for your participation, for completing exercises and presents tests that help you retain the material and show you your level of proficiency.

However, the most important aspect of MANKIND is still to be discussed: the aspect of customisation that makes the learning modules fit your needs: your needs will be different from the needs of others for at least three reasons.

First, different persons have different learning styles. According to the often quoted theory by Meeker persons belong to one of the three types: verbal, symbolic and visual. In a perfect environment each „module of knowledge" should exist in a verbal, a symbolic and a visual form. Depending on the individual learning and retention style (that can be determined by appropriate pre-tests) you should always receive modules that correspond to your learning style, a style you may wish to „override" once in a while. Even within styles there are differences.; you may prefer text to be visually displayed or spoken; often a few written words but a fuller audio explanation (if selected) may be the most desirable mode - particularly if you use the material not for self-study but e.g. for teaching others (in a classroom situation with a videobeam).

Second, different persons have different backgrounds. Learning material has to be broken up into very small modules. Intensive pre-tests should be used to determine which modules are useful in which order. This combination of modules depending on the person's background is only possible if links between modules are not part of the modules but e.g. available as structural information or such.

Thirdly, the environment (equipment, bandwidth, location of equipment, ...) and how it is going to be used (by a teacher, a student, a group of students, ...) will also influence the kind and format of the material applicable.

Putting this together, learning environments without customisation facilities can never provide satisfactory solutions. In a WWW environment this means that ordinary servers won't suffice unless an exorbitant amount of scripting is done. Hence the more powerful WWW solution Hyperwave was chosen as basis for MANKIND.

3. Summary

In section 2 we have presented ten theses; ten essential ingredients that we believe are minimal requirements for a solid integrated networked teaching and learning environment.

The ten theses are quite open-ended. Much work will have to be invested to achieve the points discussed, and many details (see e.g. [Maurer 1996b]) have not even been mentioned. However, a concrete attempt to implement a system called MANKIND on the basis of the theses is well under way. By combining Hyperwave [Maurer 1996a] and HM-Card [Maurer et al 1996] theses 1-6 and 9-10 have been implemented in first versions (and are indeed in successful use) while theses 7-8 will be ready in a preliminary form by end of 1997.

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Enhancing Student Learning through the use of a Multimedia Interface .

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Abstract: This paper describes the design of an intelligent multimedia interface to enhance students' understanding of a particular lecture topic. This interface currently caters for the topic of Knowledge Based Systems. The package addresses the problem of lecturers not being able to interact directly with students due to the increased numbers of students on courses. This is achieved by enabling students to interact with the interface on a one-to-one basis and to access information from the interface which may have eluded them during the lecture. Thus teaching is supplemented with minimal time constraints, whereas class interaction or participation can slow down the delivery of teaching materials. The interface uses extensive multimedia facilities to present information in a manner which enables learning to be as effortless and enjoyable as possible for both able and disabled users. The interface was created using the HipWorks authoring application which makes use of the UNIX environment.

Key words: *Computer-Based Training, Multimedia, HCI*

1. Introduction

Computer-Based Training (CBT) systems have the ability to incorporate different technologies, such as video, sound, digitised images and animation. Such systems have been widely accepted in certain domains to help or supplement textual teaching such as lectures and seminars. This ability to invoke user participation through interactive means has made the approach an area for further development. One of the most important issues in education is the format in which information is presented to students. This application seeks to address this problem by concentrating on the usability of the interface. That is to say, a bad interface will have a negative effect on learning as it will not entice user interest and instead of being an aid to the learning process it will become a drawback and a hinderance.
Existing similar systems lack the complete interaction that is desired to encourage students to utilise such learning tools. In an attempt to eradicate this situation this application was based on the concepts of good HCI principles (Preece, 1994). Thus multimedia was incorporated to sustain the students' interest by demonstrating an interactive and intelligent learning environment to supplement the lecturer's teaching of knowledge based systems. The interest and interactivity of the student was generated through the integration of text, graphics, animation and sound which added an encapsulating dimension to the previously static lecture notes.

2. The use of hypermedia to encourage learning.

Although students may leave college with degrees, they *are taught superficially about great discoveries instead of being helped to learn deeply for themselves* (Kay, 1991), therefore some aspects of the teaching material will have been scantily understood. This application addresses this problem by presenting a dynamic interface through which a user can sustain interest and thus enlarge their concentration span over that of '*flat-text*' reading. In order to generate a more compelling environment, multimedia objects are built into this system using a interlinked hypermedia structure through which the '*flat-text*' syndrome is replaced by visually enticing

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graphics, motion (video and animation) and sound. The multimedia objects which are incorporated into the system are characteristic of everyday living, exhibiting identifiable, representable and recallable properties, which induce productive interactive learning.

3. The Need for Lecture Support.

In a typical lecture a lecturer's role is to teach many students simultaneously in a lecture theatre. Hence, the teaching process is formal and time-constrained. This has an adverse affect on the learning process of individual students as each has their own '*information processing capability*' which may require a more informal approach to learning. Hence, there is a subsequent lack of student attention and information intake. Figure 1 below highlights the factors that were taken into consideration when designing the system.

• **Supported Activity**	- To encourage the interactive participation of students through an interactive interface.
• **Users**	- Third-level Computer Degree students - Able-bodied students - Disadvantaged students -Visually impaired - Mature Students[1]
• **Level of Support**	- Highly interactive hypermedia interface
• **Form of Solution**	- UNIX environment stand-alone CBT interface

Figure 1 Design Considerations

4. User Analysis

This interface is aimed at second year computer degree students and every different type of user within this domain must be accounted for, see Table 1. In today's society we have more and more people opting for continued or further education. Taking this into account, although the target audience will inevitably be studying computers, their whole physical and mental aspirations towards computers will be different. It should be noted that age is accompanied by a deterioration in the body's functions, and in particular, their eyesight and mental abilities. As stated by Morris (1994) '*there is a decrease in many physical, visual, and cognitive skills with age.* Therefore it was necessary to address these issues when creating the system interface so that the disadvantaged user would be able to benefit as much from the interface as the abled user. Also voice input is provided as Blanck (1994) stated that "*The speed and convenience of voice input enjoyed by mainstream able-bodied computer users often translates to greatly enhanced access and productivity for people with disabilities. The greatest benefit accrues to people with mobility and vision impairment.*"

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[1] Mature students have been categorised as disadvantaged due to certain characteristics like loss in vision and reduced memory or information processing capacity. This is aimed at the more senior mature student.

Table 1: User Analysis

•User Characteristics

- student, also mature student
- professional or part-time student
- personal use
- important supplement to users' study schedule

•Skills

- high general computing skill level
- not all have UNIX skills
- general knowledge of such learning systems

•Conclusions

- keep interface simple and usable
- usability and functionality greater than for a text book
- minimise typing, and be quick and easy to learn

5. Usability factors.

It is necessary that the system adheres to usability factors. The following list identifies each usability factor that was taken into account and how it was considered during the systems design:
(1) ***Speed of Operation*** -This is quite important, but the speed of operation can be overlooked in favour of a better learning system.
(2) ***Completion Rate*** -Current lecture topics take on average 3 hours to be delivered. This tutorial system intends to deliver a topic within 30 -45 minutes depending on continued user interaction.
(3) ***Error-free Rate*** - The system has been designed to be as 'idiot' proof as possible. Any errors that occur are well documented by visual and auditory cues.
(4) ***Learnability*** - The system must focus heavily on this aspect. A user should naturally and quickly learn how to interact with the system. This should occur after the first interaction with the system.
(5) ***Retainability*** - The system must enhance the user's short and long-term memory. The user should not have to remember how to interact with the system as the system should be self-explanatory.

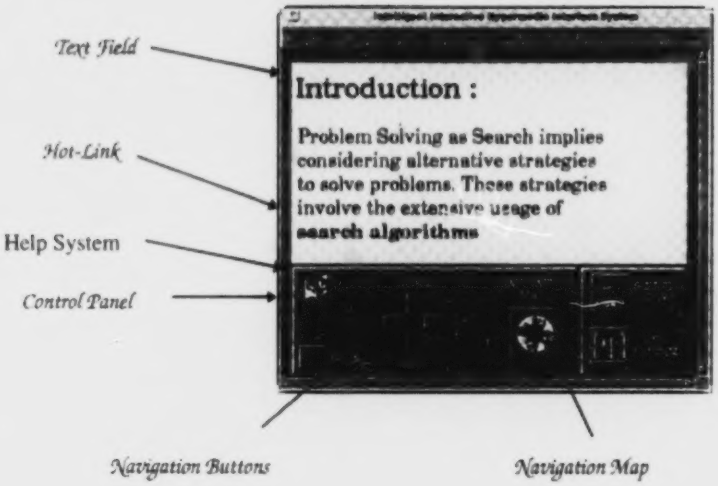
6. Hipworks and Prototyping.

Hipworks was chosen as the software development environment as it provided both hypertext and multimedia facilities thus enabling information to be presented in a combination of media formats comprising of voice, graphics, animation and text. Also Hipworks operates on a Unix platform which was advantageous as the Unix laboratory in the university was under-utilised and thus students could easily access a machine in order to run the application. Hipworks also was particularly suited to developing the system via prototyping.

As Gould (1988) points out , *'we miss things during analysis and simulation, and we rely on prototype testing to bring these out'.*
As usage (experience) comes before knowledge it was required to keep a set of student users (evaluators) to experience each deliverable of the prototype as it was made. As each interacted and found weaknesses or strengths, it was necessary to update the prototype to adhere to these findings.

7. System Implementation

The systems is composed of three sub-systems which are the help system, the system interface and the navigation system. The system interface was implemented first and then the other two sub-systems were added. Figure 2 shows the layout of the interface and all its components. It should be noted that the layout shown in Figure 2 is consistent throughout the system so that the user is not confused by different screen layouts.


Intelligent Interactive Hypermedia Interface System
Text Field
Hot-Link
Help System
Control Panel
Navigation Buttons
Navigation Map

Introduction :

Problem Solving as Search implies considering alternative strategies to solve problems. These strategies involve the extensive usage of **search algorithms**

Figure 2 System Interface

Text field: This component is very important to the system as it shows the information space of the system. This field presents the course material in an interactive way.
Control panel: This is where the navigation and other interactive system components are placed. Figure 2 illustrates the buttons for selecting the '*Help*' and '*Navigation*' facilities. The main components are the navigation buttons of '*Home*', '*Previous*', '*Next*', and '*End*'. Error messages appears only when for example the '*Home*' button is clicked or when the home page has previously been activated.
Sound ON/OFF: This is a toggle button which once depressed will either switch the sound 'on' or 'off', depending on its current state.
Navigation System : Navigation within all hypertext-based systems presents problems in terms of controlling the interaction path of the end-user so that the user never becomes lost whilst interacting with the system . This systems solves this problem by recording the students' interaction and offering a graphical display of the users' interaction within the information space (See Figure 3, below).

Indicator
Intelligent Interactive Hypermedia Interface System
Legend
Nodes

Figure 3: The Navigation System.

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Each node is represented by a command button which when depressed will take the user directly back to that scene and the indicator then marks the users' current location within the system. This was achieved by making a text field invisible or visible when a user has entered the navigation area from that node. Also, the legend was developed through a label and text field.

Error Messages : Consideration was given to users who select an option that is unavailable or that cannot be invoked, for example if a dead-end has been reached.

Help System : An objective of the interface was to allow the end-user to have access to help at any point during an interaction. Therefore the help facility may be selected from any point during a user interaction. Once the help system is activated the user receives help by clicking on the appropriate hotword (See Figure 4, below).

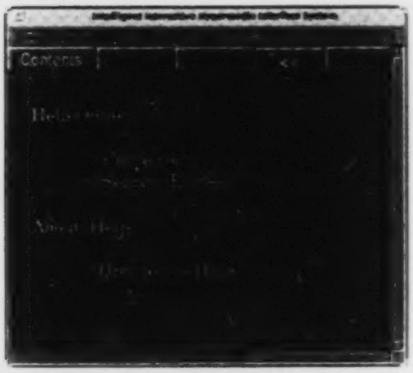

Figure 4. **The Help System**

8. Evaluation of the Interface.

The procedure for evaluating the interface involved users completing a questionnaire as well as directly observing how users interacted with the system. The questionnaire addressed the HCI guidelines (which were applied in designing the system) and the 5 deliverables as set out by ***Software Ergonomics in EC Directive 90/270/EEC*** (Anderson, 1996) which states that the interface must :

(a) *be suitable to the task,*
(b) be *easy to use and adaptable to users' level of expertise,*
(c) *provide feedback,*
(d) *have a format and speed of display which is appropriate to operators,*
(e) *have obeyed the principles of software ergonomics.*

The following observations were made in the light of these guidelines. It was discovered that the students thought that the interface presented no real difficulties for users in using the information space. However some students requested that more attention should focused on the expert user. For example the '*goto*' command allows direct access to any particular scene, but students thought that this was not evident from the interface and instead consequently they had to go laboriously through the menu. It was also thought that the interface would be extremely useful for the representation of CBT material but that extra functionality, such as permitting students to record their own on-line notes was found to be desired by some users. Finally, through direct observation, it was found that the initial reaction of the students to the interface seemed to one of interest. It was found that the interface enticed learning and was acceptable to all levels of users, in that even the first time users of the interface appeared competent in using the system. Disadvantaged users also were pleased with the interface especially the optional voice input, large text and uncluttered screens. It can be concluded from this that information that is presented through a hypermedia environment incorporating visual and auditory cues aids the learning process by providing a visually enticing learning environment which is much more interesting for the students than a text book.

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9. Enhancements

A possible enhancement to the system would be the inclusion of a management system to guide the student through the tutorials and report back to the lecturer on the student's progress, the help that has been requested, and the results of the tests which are included in the tutorials. This aspect thus leads on to an important implementation strategy known as '*Distributed Multimedia*' or in the case of CBTs '*Distributed Teaching*'. This management system would be best utilised in a network environment where lecturers could be contacted directly via an e-mail mechanism. Statistics could also be gathered from this distributed approach, and will offer greater flexibility to the user than stand-alone interaction. Another enhancement to the system would be to make the system adaptive. For example an '*intelligent*' mechanism could be added through which the user's interaction would be monitored by the system and determine the level at which to aid the user (this is dependent on whether or not they are in fact expert or novice users). This would eliminate standardisation of the interface and instead customise the interface to fulfil the requirements of each user.

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Evolution of an Educational Database: From Telidon to CD-ROM to Virtual Reality on the Net

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Abstract: The success of an electronic product or educational software depends on the author's ability to provide relevant information, respond to technological developments in the classroom and support the teaching/learning process. This paper explores these issues and their resolution during the development of an educational database intended for secondary students. The product was created by Statistics Canada in response to a request from the education community for timely access to social and economic data on Canada. It has evolved from an on-line database, to a stand alone CD-ROM and, in the fall of 1997, will have come full-circle, to an on-line web service.

Evolution

Originally called CANSIM/Telichart, the project resulted from a request from a single school. Richmond Hill High School was interested in data and "real-life" computer technology. They approached Statistics Canada in 1986 and were granted direct access to our main database through a VAX computer. Telichart enabled users to select and display data as a chart or list. Users could perform basic calculations and some analytical functions such as moving averages and regressions. No one could describe the system as user-friendly: documentation was a number of 3-inch binders containing data series identification numbers and a two-page list of commands. Support consisted of a number of on-site visits and telephone contacts.

Intended for Business Studies, the project quickly caught the attention of teachers in other subjects such as geography, history, economics, family and social studies, mathematics and computer sciences. The degree of interested caught us off guard; our enthusiasm for tables of numbers is not shared by many people. Senior management at Statistics Canada believed the project offered a unique method of fulfilling our mandate, while supporting the provinces' educational objectives to improve students' knowledge of Canada, facilitate the development of analytical abilities and advance computer skills.

For the benefit of international participants, education in Canada is a provincial responsibility, while the centralized statistical system is funded by the federal government. Even though Statistics Canada, the central statistical agency, is apolitical and has an arms length relationship with policy departments, it must tread very carefully in provincial jurisdictions. Many decisions taken during the development of this product reflect the boundary between federal and provincial responsibility

Encouraged by the success at Richmond Hill, we began field testing with three additional sites in the Ottawa area, then expanded the test to 40 sites across Canada in 1990-91. The documentation was expanded to include a user's guide, a quick reference card and examples of how teachers use Telichart. Support remained the same.

Two main issues were brought to light by the field test. The delivery system was identified as a problem by both users and providers. Educators liked the interactive feature of the system but were concerned that connection charges could become onerous. From our end, the number of sites who could connect to the VAX was limited. Both groups felt improved documentation was needed. Educators wanted immediate access to direction and technical support, while we felt on-site visits would be physically, as well as, fiscally impossible if the product went into wide distribution.

The delivery system problems were resolved by developing a stand alone product. Fortunately, the increasing number of schools owning CD-ROM readers allowed us to consider this option. Renamed E-STAT, the CD-ROM stored current and historical data on Canada and Canadians including results from the 1991 Census. The first version was released in 1992 using DOS-based software to select and present data as tables, graphs or maps.

Spirit of cooperation that gave birth to the product in the first place continues. To broaden access to E-STAT, Statistics Canada has actively pursued licensing agreements with all the provinces and territories. Seven provinces have signed licencing agreements which have the effect of lowering the price to individual schools. An agreement with British Columbia, required the development of a Web version of E-STAT. This version is being filed tested and eventually will be available through our Web page as a subscription service. Subscribers will also be given a CD-ROM which may be networked or run as a stand alone.

Providing Information and Keeping it Relevant

Given our mandate to report on the social and economic well-being of Canada and Canadians, Statistics Canada can provide a wealth of information and, unlike many other application authors, does not have to apply for copyright approval. Rather than tailoring subsets of data to match curricula, we decided to rely on educators to select what they need. We actively seek partnerships with other departments, levels of government, business and individuals.

The success of E-STAT and its predecessor is largely the result of individual champions working in their schools. We continue to capitalize on this type of relationship by supporting any initiatives with our in-house resources in return for permission to publish or otherwise disseminate the outcomes. Listening to the feedback from these champions and implementing their suggestions has been an important feature of the development process.

One of the first comments we heard was "delivering data is not enough; it must be integrated in the curriculum." Materials developed during the Telichart phase and various field tests were included with the first version of E-STAT, and elaborated in each succeeding release.

Feedback is often contradictory. For example, some users feel there are too much data on E-STAT, while others ask us to include more data on specific topics. Early on we decided to maintain the original level of detail and, in fact, to add data from other sources believing this would better serve a national audience. However, the volume of data can be overwhelming so every effort is made to help users pinpoint the data they need. Changes are made to both the software and the documentation on an annual basis to improve the accessibility to data. School librarians pointed out the difficulties with our keyword search, as a result we have developed a topic list which is closer to the terminology used by students.

A portion of our University Liaison Program (ULP) focuses on Faculties of Education. The universities receive E-STAT and agree to provide information on its use by staff and students and suggestions for improvement. The coordinator also works with individual professors delivering training, facilitating access to subject matter specialists at Statistics Canada and encouraging academic endeavours. Several professors have spent parts of their sabbatical at Statistics Canada. The ULP sponsors two award programs. One recognizes excellence in curriculum design by pre-service teachers. The other is offered for graduate student research and is offered jointly with the Canadian Society for the Study of Education and the Canadian Educational Research Association.

Formal avenues are also used to evaluate E-STAT when a strong trend in the feedback becomes apparent. The earliest versions of the CD-ROM are a case in point. Dr. B. Griffith and Dr. J. Paul of the University of Calgary conducted a survey of users in the Western provinces. The first section in their report provided information on who purchases/uses E-STAT. "Overall it is safe to say that the responders are mature, very experienced teacher-librarians or male administrators who have a high level of university training and regard themselves as computer literate." The second section of their report summarized respondents comments on the product. "Although some of the purchases and users have acquired various document packages with their purchases, there was no indication that any of the options or packages was consistently helpful .... most respondents in Section B spoke of E-STAT in terms overwhelmingly as "not user friendly". This persistent comment permeates the survey responses."

Many of the problems identified in the first release of E-STAT were corrected in subsequent editions. However, to balance rapid advances in technology and limited resources for development, Statistics Canada decided to skip to an Internet version of E-STAT rather than develop a Windows version.

Technological developments in the classroom

A number of issues surface under this heading. First, technology in Canada tends not to be in the classrooms. Rather, it is housed in computer labs or school libraries. We have been rather slow to realize this fact; much of the E-STAT documentation is targeted to individual teachers working in their classroom. Only now are we beginning to develop materials and strategies which a librarian can use with students or teachers.

Second, new technologies are adopted slowly by schools, but enjoy a considerably longer life than in the business world. Also, purchasing decisions are local, most often school boards choose one format, but occasionally we will find a school with both MAC and DOS-based machines. E-STAT is currently available for both MAC and DOS platforms on the Web. We expect to continue supporting all of these formats for sometime.

Third, the computer literacy of educators may prove to be a barrier. Recent survey results show that seven of 10 secondary school teachers report using computers but for an average of less than 10 hours a week, suggesting that their comfort level is not high (Oderkirk, 1996). These findings confirm our field experience. E-STAT is interactive and, therefore, requires a fairly sophisticated user. Much of our work is now focussed on developing classroom-ready materials and training educators.

Supporting the teaching/learning process

We are building an inventory of lesson plans written by professional educators. The activities are curricula based and specific keystroke commands are embedded in the student handouts. They are published in the teachers resource which is part of the E-STAT documentation. Feedback has pointed out that the CD-ROM and printed materials often get separated so we began posting the materials to our Web site with the 1995 version and including it on the CD itself with the 1996 version. All of our materials are covered by a blanket copyright approval allowing unrestricted use for nonprofit educational purposes.

Another method we have used successfully to reduce anxiety and encourage educators to use new technology is to conduct workshops and recommended teaching strategies. Although the following strategies were developed around E-STAT, they can be applied to many types of electronic products.

Hands-on workshops in the lab or classroom

Over the last several years, Statistics Canada has developed a workshop format to introduce in-service and pre-service teachers to E-STAT. We recommend that a similar format be used with intermediate or senior students.

The optimum lab configuration is one computer for every two or three participants. (One student reads the instructions, the second operates the keyboard and the third verifies the actions of the operator and records results.) The best lab arrangement is u-shaped or widely spaced rows that allow the instructor to view each computer screen easily.

Using one of the computers and a LCD panel or a 20" monitor, the instructor demonstrates an E-STAT lesson giving a running commentary on the keys being used. Participants are asked not to use their computers until the demonstration is complete. The same exercise which includes specific computer instructions is provided to all participants. Participants complete the activity on their own.

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Workshops usually include two activities one for each of the main databases on the CD: CANSIM Time Series and 1991 Census of Population. Generally, a DOS workshop can be completed quite handily in two hours, while a MAC workshop can be completed in 1.5 hours.

Preprinted maps, graphs or worksheets in the classroom

In many schools, scheduling time in the computer lab can be difficult or impossible. Instead of taking a class to the lab, it is possible for the teacher to bring the data to the students by using the keystroke commands in the lesson plans to create worksheets, graphs or maps. Printed copies can be distributed to the students for analysis along with the activity sheets containing the actual assignment.

Single workstations

Another method would be for the teacher or E-STAT student coach (see the item below), to store a series of maps or graphs on a classroom, lab or library computer using E-STAT's saved graphs and maps function. Students can be referred to this computer as a workstation for an assignment. They retrieve the saved items for analysis. This approach reduces the demand for scarce computer resources and almost guarantees a successful experience.

Student Coaches

Given the proliferation of educational software and reduction in technical assistants in most school boards, many teachers find the suggestion to use students as coaches intriguing. The objective is to let a few students train themselves in how to use E-STAT. The self-training might be an option to replace a major assignment in any course or offered in a computer skills course. The teacher uses a checklist to test the student's knowledge. Those students who pass are certified as coaches and may assist their peers.

Train the Trainer Workshops

Licencing agreements often include a training component for in-service teachers. After the training has taken place in the sponsoring province, it is adapted and made available to all regions of the country.

Conclusion

An electronic product designed for the education market must be dynamic but its development must keep pace with adoption of technology by schools and educators. The product should also facilitate the learning process for both teachers and learners. Formal and informal partnerships are necessary to ensure the product stays current and relevant.

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Research on Student Approaches to Learning in Computer-facilitated Learning Environments

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Abstract:
This paper will attempt to draw together two threads in current educational literature—a general literature on students' approaches to learning in higher education, and a growing collection of descriptions of and reflections on the use of computer-facilitated interventions for the enhancement of student learning. A model of student learning will be presented where the importance of students' approaches to learning is emphasised. Evaluation data from several computer-facilitated projects will be presented in terms of how students develop and modify their approaches to learning.

Introduction

There is now a substantial literature on why computer-facilitated interventions should enhance student learning. Much of the actual evaluation which supports assertions of enhanced learning is superficial and based on questionnaire and interview data about student attitudes to the new material. We have a range of exciting designs designed to encourage new learning modes and strategies, but insufficient understanding about how students actually go about the learning process in these new learning environments. There is little information about how students operate in computer-facilitated learning (CFL) environments—what sort of approaches they adopt, and how these approaches might be modified when new strategies are adopted. In this paper I will look at three general methods which can be used to gain information about student approaches to learning in a CFL environment—questionnaires, interviews and mapping of audit trails.

A model for student learning

[Biggs 1989] presents a model for student learning in terms of three types of components—those which exist prior to learning (Presage factors) such as existing student characteristics and the overall teaching and learning context; the Process factors relating to how students and teachers approach their respective tasks; and the Product as student learning outcomes. Biggs presented this '3P' model in two ways—as a model of student learning and applied to teaching. In figure 1 [Fig. 1] I have combined these two representations into one heuristic model which indicates clearly how student learning relates to both student and teacher perceptions and approaches.

As [Biggs 1989], [Biggs 1993] makes clear, we should not view this model as a linear progression. Rather, it is a dynamic, interactive system with changes in any factor affecting other factors. Understanding the influences of curriculum design on student learning is a complex issue and several factors need to be considered, for example:

- courseware design for the overall set of learning experiences [Lajoie & Derry 1993];
- the nature of teacher-student, and student-student interactions [Crook 1994], [Laurillard 1993];
- approaches to assessment [Ramsden 1992];
- skills and approaches of teaching staff [Samuelowicz & Bain 1992], [Trigwell et al. 1994], [Bain & McNaught 1996]; and
- relationships between teaching approaches in one subject to other subjects in the course [Wills & McNaught 1996].

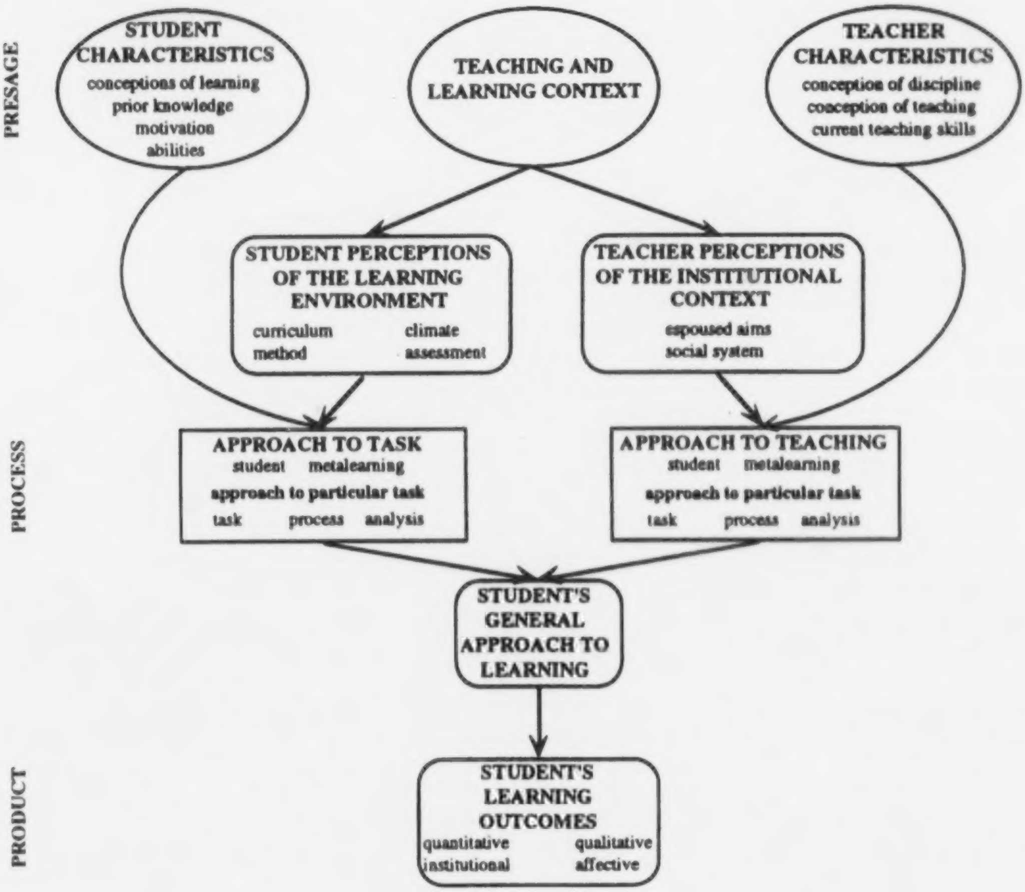
PRESAGE
PROCESS
PRODUCT
STUDENT CHARACTERISTICS
conceptions of learning
prior knowledge
motivation
abilities
TEACHING AND LEARNING CONTEXT
TEACHER CHARACTERISTICS
conception of discipline
conception of teaching
current teaching skills
STUDENT PERCEPTIONS OF THE LEARNING ENVIRONMENT
curriculum
climate
method
assessment
TEACHER PERCEPTIONS OF THE INSTITUTIONAL CONTEXT
espoused aims
social system
APPROACH TO TASK
student metalearning
approach to particular task
task process analysis
APPROACH TO TEACHING
student metalearning
approach to particular task
task process analysis
STUDENT'S GENERAL APPROACH TO LEARNING
STUDENT'S LEARNING OUTCOMES
quantitative
qualitative
institutional
affective

Figure 1: [Fig. 1] Presage, Process and Product in teaching and learning (after [Biggs 1989])

Student Approaches to Learning

There is a well-developed collection in the general higher education literature on students' approaches to learning—for example, the work of Biggs and others about students' adoption of surface, deep or achieving approaches to learning. In surface or reproductive learning understanding is limited in scope and is not integrated into students' existing knowledge frameworks. Students wish to avoid failure but don't work too hard. Deep learning involves the refinement and assimilation of understanding; this can enable students to feel confident in applying knowledge and/or to be critical in evaluating new ideas for themselves. Such students tend to read widely, discuss and reflect. An achieving approach is a pragmatic approach where working within the prevailing system to maximise achievement dominates students' decisions about study. An achieving approach does not preclude deep learning; rather it reflects students' dominant concerns about learning in higher education. These approaches have been identified in several studies, e.g. [Biggs 1979], [Biggs 1989].

Case Study 1: Practical Physiology: Questionnaire Data

The second year undergraduate practical physiology course for science students at The University of Melbourne was radically revised in 1994. The new course was designed with an emphasis on scientific method rather than on the development of explicit skills or learning factual knowledge. Each topic now covers a three-week cycle of pre-practical work, experimental work and post-practical follow-up. Computers are used in the laboratories to streamline data acquisition and processing, provide on-line help using multimedia resources, and provide feedback and quizzes. In 1994 questionnaire data was collected on:

- student perceptions of the aims of the course at the beginning of the course and after experiencing the practical course and associated lectures, and
- student approaches to learning.

Questionnaires with open-ended questions were administered during the first and final weeks of semester 1. 136 students filled in the questionnaires. The overall picture was a positive one. Three-quarters of the students seem confident that they have learnt important skills and that the structure of the course is a useful one. A modified version of the Course Experience Questionnaire (CEQ) [Ramsden 1991] was given to the students at the end of the course. The CEQ has five scales—good teaching practice, emphasis on independence, clear goals, appropriate assessment, and appropriate workload. These five scales have been extensively trialed and have been shown to be reliable and valid performance indicators for teaching quality in higher education. Students' perceptions of the learning environment were positive on all scales [McNaught et al. 1995].

So, in this computer-facilitated environment, that students consider to be valuable, how do they approach their study? In what way has this experience altered their perceptions of how to approach studying physiology?

A questionnaire was given to students at the end of two semesters of the new practical physiology course. The ten items selected were based on the Study Process Questionnaire [Biggs 1987]. Ten items only were chosen because of concerns about questionnaire fatigue. The items chosen, and an interpretation of the student responses are given in table 1 [Tab. 1]. In the comments column the predominant approach is classified in terms of whether the majority of students appear to adopt surface, deep or achieving approaches to learning. There were 50 respondents.

An achieving approach to learning is strong with this group of students. There is a strong rhetoric about deep approaches and holistic understandings in university education, but the reality is that even a course that students find satisfying and interesting is only one small section of their experiences of learning and can make relatively little impact.

Question	Comments
1. I think browsing around is a waste of time, so I only study seriously what's given in the practical manual.	achieving
2. While I am studying this practical course, I think of real life situations in which the material I am learning would be useful.	achieving -> deep
3. I learn some parts of this practical course by rote, going over them till I know them by heart.	surface -> achieving
4. I feel that this practical course became interesting once I became involved in studying it.	deep
5. In studying this practical course I am focussing more on the procedures than the theoretical material.	achieving
6. I try to relate what I have learned in this practical course to material in other sections of the physiology course.	deep
7. I think it is only worth studying material which I know will be examined.	achieving
8. I believe strongly that my main aim in studying this practical course is to understand it for my own satisfaction.	deep
9. I am prepared to work hard in this practical course because I feel it will contribute to my employment prospects.	achieving
10. Studying this practical course has challenged my views on how the world works.	achieving -> surface

Table 1: [Tab 1] Physiology student perceptions about their approaches to learning (end of course)

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Case Study 2: Veterinary Microbiology: Interview Data

This innovation involved the development of interactive, multimedia databases of veterinary curriculum materials, linked to a revised set of educational objectives, a range of other learning situations and more appropriate assessment procedures. The expanded set of learning objectives required students to acquire information management and problem solving skills, as well as understanding bacterial and fungal diseases of animals. The development of group learning skills and communication skills were also explicitly built into the course. The curriculum rationale is explained in detail in [Whithear et al. 1994]. In this computer-based, case study learning system (CB CS LS), 24 lectures, 40 hours of laboratory sessions and course notes over 8 weeks were replaced by no formal lectures; course material in multimedia databases; 40 case studies with associated quizzes, 6 of which were intensive laboratory exercises (10%); 5 short essays (20%); 1 seminar (5%); literature review (15%); and 1 'open computer' examination (50%) (assessment percentages in brackets).

Evaluation [McNaught et al. 1994] indicated the following positive outcomes:

- Students took more responsibility for their own learning. They were expected to acquire new information from a variety of sources, including primary sources, and to develop skills to control their own information using a computer.
- There was no requirement to memorise by rote. Learning was predominantly contextual, using simulated, problem-based case studies.
- Higher order cognitive skills were sought and demonstrated in the presentation of seminars and essays, and in the 'open computer' examination answers.
- More opportunity was provided, and emphasis placed, on collaborative learning.
- More opportunity was provided for students to develop written and oral communication skills.
- Continuous monitoring and feedback (both quantitative and qualitative) of student progress was provided.
- Increased awareness of, and interest in, the subject and improved practical skills were demonstrated in this class compared with previous experiences with classes taught in the conventional manner.
- Students acquired familiarity and skills with computers and computer networks.

In this radical curriculum shift what can we learn by interviewing students about how this change might have changed their approaches to learning?

The richness of this qualitative data is often undervalued. Initial reservations about this new learning style were strong. This 'culture shock' is a main element in implementation and, initially, this factor was underrated by the project team. Students can experience a culture shock with educational innovation. They have the idea that they've been trained and rewarded for a particular style of learning which has focussed on memorisation—that this *is* effective learning. Students' acquired model of learning is thus at variance with many innovative ideas which focus on interdisciplinary studies, teamwork, and deep learning. This disjuncture can create difficulties, perhaps more than people realise at the outset. In a session on collaborative learning early in the course, the following student quotes were obtained from walking among the groups who were talking about how they had previously learnt things.

- *I don't learn anything which is not Veterinary Science.*
- *We're too busy in the course to do any thing else.*
- *If you get together in a group you only waste time.*
- *I'm intending to learn the course this way: I've got all last year's notes from the student who did this course last year and that's the way I'm going to learn the course. I don't think these case studies are going to do much for telling me how to save a cow in middle of the field at midnight. I'm going to be reading those and memorising those notes.*
- *I'm competitive and individualistic and have been rewarded for this so far. I don't want to change.*
- *I'm already a good information manager; otherwise I wouldn't be here.*
- *Well, there's social skills you might learn in a group and there's intellectual skills, and they're all quite different.*

This was a difficult and intense session but brought the idea of talking about how one learns out into the open. At this stage, many students were clear that they didn't see conceptual learning as being something which involves interaction. This became an ongoing discussion throughout the course and contributed to the positive outcomes. We certainly feel that this open exploration about learning is unusual in veterinary courses and of real benefit.

About a third of the students did find the session interesting.

- *Yeah, this was worthwhile. I don't know. I haven't had any experience of this sort of thing because I've always learnt individually, but this has given me something to think about.*
- *But it was useful to talk about reflection.*
- *All this learning stuff ... we've done before; it was all pretty elementary really. In general, it was all common sense.*

These comments can be contrasted with the more positive and pragmatic comments made in the group 'debriefing' session at the end of the 1993 course. This workshop session enabled students to amplify any points they wished. The 'baldness' of categories from a questionnaire are thus overcome and the possibility of accurately describing students' position on any issue was greatly enhanced. Students expressed clear appreciation at this opportunity to be involved in evaluation. Their appreciation of the efforts made by staff in the course was very high. They commented on the range of learning styles that students may adopt and felt that the course structure provided a flexibility that allowed students to develop their own strategies for organisation and learning; for example, by individualising their study habits, by timetabling their out-of-hours computer sessions and by structuring protocols for their group activities. During the course, significant shifts had occurred on students' approaches to learning.

The evidence the project team has it that these shifts were not sustained. One eight-week experience is unlikely to alter students for long when other subjects encourage information reproduction.

Case Study 3. First Year Chemistry: Visual Mapping of Individual Questions

ChemCAL is an interactive computer-based tutorial package for the teaching of introductory and first year tertiary chemistry. ChemCAL software [Fritze & McNaught 1994] uses on-screen video and animations, a range of question formats and three levels of direct response to students; it also has built-in logging that provides two-way feedback to both students and course supervisors.

All the ChemCAL modules are designed to assist students towards the development of a deep understanding of chemical concepts and of an integrated understanding of the relationships between topics. To help achieve these aims, there is a high level of interactivity coupled with detailed assistance available to students in all modules. There is very little straight didactic material. There is also a large amount of visual material present in the modules as animations and video clips, designed to help students develop their own mental models of the central concepts of chemistry. Approximately 70 hours of instructional material have been developed to date. Evaluation has indicated positive outcomes [McTigue et al. 1995].

Visual mapping of student audit trail files [Fritze 1994] can be used to examine the actions of students. In this example, a single screen of one chemistry tutorial will be discussed. The question required that they enter the correct structural name for an organic molecule presented in diagrammatic form. At any stage, the student has access to various levels of assistance (in addition to summoning the real life tutor!). Students were familiar with the program's operation having completed six previous modules. For each item students can ask for a hint, ask for an explanation, ask for an answer to be checked or make a comment.

Once the first question item has been completed correctly, another one is displayed. For this question there are eight items, labelled 'EFLDq1' to 'EFLDq8' in figure 2 [Fig. 2]. Figure 2 [Fig. 2] provides two contrasting student styles. Student A shows a determination to complete each question item alone, making heavy use of support information provided before eventually attaining the correct answer. Student B, on the other hand, has requested the solution in all but item 3. It is tempting to infer that student A is adopting a deeper approach than student B. Clearly this is insufficient evidence but viewing large numbers of these maps does enable one to get a sense of student strategies and approaches. They can be viewed as a Quicktime movie. These maps are also an excellent stimulus for post-session interviewing [Fritze & McNaught 1966].

Three methods of collecting data about students' approaches to learning have been presented here—questionnaires, interviews and visual mapping of student logs. All methods provide insights into student approaches to learning. Further emphasis on this aspect of evaluation is needed. There is evidence that using well-designed CFL can encourage deep approaches to learning but the strategies need to be reinforced in several areas of the students' experience. One-off experiences do not result in lasting changes.

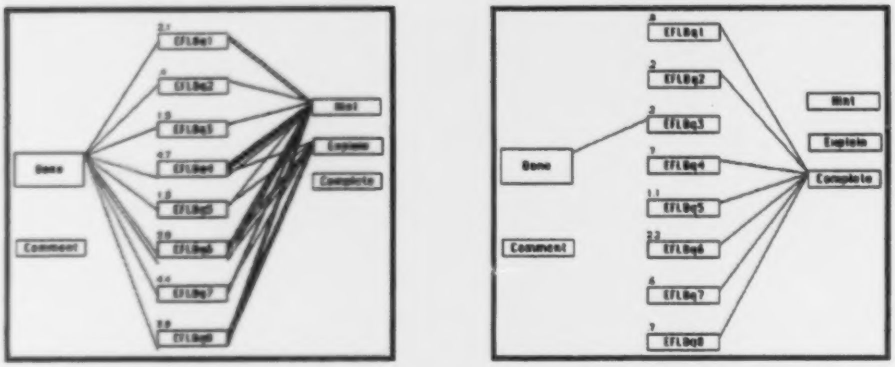

Figure 2: [Fig. 2] Mapping of a single CAL tutorial question for student A (left) and B (right) (from [Fritze 1994], p. 283)

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PREFACE

Welcome to ED-MEDIA/ED-TELECOM 97 in beautiful Calgary, Alberta, CANADA. It is fitting that this tenth in a series of research and development conferences is being held in the same city that hosted the first meeting, the International Conference on Computers and Learning (ICCAL) in 1987. Over the last decade, thanks largely to the efforts of scores of volunteers, ED-MEDIA/ED-TELECOM has become one of the top events of its kind anywhere in the world. An annual event since 1993 when the conference became associated with the Association for the Advancement of Computing in Education (AACE), ED-MEDIA/ED-TELECOM retains many valued aspects of the earlier conferences, most importantly the truly international nature of its participants. At the same time, the conference has grown in sophistication and scope, and we hope that you will find that this year's version lives up both to your memories and your expectations.

In areas as heavily invested in innovation as educational multimedia, hypermedia, and telecommunications, some might question the meaning and value of holding face-to-face conferences for which presentations must be submitted and prepared months in advance. After all, changes in the technologies we employ occur at a faster and faster pace, and last month's cutting-edge news is this month's dull topic. However, most of us recognize that as conference participants we are not so much interested in technologies as ideas. New ideas are often shared, critiqued, and reshaped through personal dialogue and group discussion. Further, we recognize that many of the most important exchanges that take place at professional meetings occur away from formal sessions. Collegial introductions at social events as well as chance meetings in the hall where you make new friends and catch up with old ones, these and many other human interactions are often the most valued and long-remembered aspects of any conference. Although the global "infocasm" described by futurists suggests otherwise, we predict that the basic human need to interact face-to-face will last far into the 21st Century.

As co-chairs of the Program Committee (PC), we have endeavored to increase the quality of the papers, tutorials, workshops, posters, demonstrations, panels, showcases and other events at this year's conference. We could not have done this without the hard work of the PC members listed on the following pages. Representing nearly twenty different countries, these individuals reviewed more proposals than ever before. The papers in this volume and on the accompanying CD-ROM survived several rounds of demanding analysis, critique, and selection, as did the other types of sessions. In addition, the counsel of the Steering Committee members was invaluable, especially in terms of selecting the keynote and invited speakers. Gratitude also goes to the AACE team, most notably Executive Director Gary Marks. Finally, we acknowledge the many and varied efforts of the Local Executive Committee in Calgary, co-chaired by Brian Gaines and Douglas Norrie, of the University of Calgary, our host institution. Thank you one and all.

A year of preparation will soon be over, and ED-MEDIA/ED-TELECOM 97 will be a memory. It is our hope that this memory will be refreshed each time you open this volume or access the conference CD-ROM, seeking information and inspiration for your future work. Further evidence of that living memory will be your continued participation in this event. To that end, we look forward to seeing you again next year at ED-MEDIA/ED-TELECOM 98 in Freiburg, Germany.

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The SHAPE of Hypermedia Authoring for Education

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Abstract: In this paper we describe an empirical study which aimed at analysing the processes involved in the authoring of hypermedia applications for education. The study consisted of interviewing either researchers or lecturers from the University of Southampton involved in the development of hypermedia applications for education. The issues addressed in the interviews were classified as either general or specialised and the study is part of a research project called SHAPE. The aim of SHAPE is to aid authors in the development of good quality large-scale applications for education.

1 Introduction

Hypermedia authoring has been a wide area of research and interest in the last few years. There are many ways in which the meaning of authoring can be understood and, consequently, many corresponding solutions offered to hypermedia authors.

Authoring can be considered a writing process [Nanard & Nanard, 95] and, in a similar way, involves the same processes used in writing: planning, translating and reviewing [Flower & Hayes, 80], [Hayes & Flower, 80]. Authoring in the large requires a lot of planning in order to develop reusable and maintainable applications [Ginige et al., 95]. And if authoring is applied to education the number of variables to analyse increases significantly.

2 The SHAPE Project

SHAPE is an acronym that stands for Southampton **H**ypermedia **A**uthoring **P**aradigm for **E**ducation. The aim of SHAPE is to aid authors in the development of good quality large-scale applications for education. In this sense, good quality means easy reuse and maintenance of information and also means that the authoring tool used influences positively the authoring process. The empirical study described in this paper is part of the SHAPE project and is aimed at analysing the processes involved in the authoring of hypermedia applications for education. Throughout this paper "author" means anyone who writes or composes a book or other literary work.

3 Methodology

The empirical study was conducted using interviews at the University of Southampton in 1996. The participants were either researchers or lecturers involved in the authoring of hypermedia applications for education and thirteen people volunteered. Nine authors were involved in all the development phases, from the design of the structural knowledge [Diekhoff, 83] for the domain and the authoring of nodes' contents to the interface design and application implementation. Three authors were involved only in the management of the development and one author was involved in the definition of the structural knowledge [Jonnassen, 93] and in the authoring of the contents of nodes. Some authors have been involved in the development of more than one application, which makes the number of applications used in our sample data (twenty) greater than the number of volunteers.

Nine applications were developed by authors who already had experience in the development of at least one hypermedia application for education. Six applications were developed by authors who had read about hypermedia but had no direct experience in the development of hypermedia applications and five applications were developed by authors who had no previous experience or knowledge about hypermedia. The number of small, medium and large applications, where we consider a medium size application to have a number of nodes between 100 and 500, was five, ten and five respectively. The domains used for the applications' content were Rheumatology, Cognitive Psychology, Sociology, Archaeology, Oceanography, Engineering, Physics, Geography and Biology.

The issues considered in the interviews were arranged into *general* and *specialised*.

The *general issues* addressed were:

- if there was a general method/methodology for the authoring of hypermedia applications for education.
- differences and similarities between the cognitive writing processes used in the development of hypermedia and non-hypermedia applications for education.
- if the links were considered essential when structuring the knowledge domain.
- the importance of representing the author's cognitive map [Diekhoff & Diekhoff, 82] in the structure of the application and if the learners needed to know it in advance.
- if the development could be divided into different phases and groups.
- if there were commonalties among the resources used.
- what was the most commonly used instructional approach.
- how the applications were introduced in the courses.
- if the authoring tool used influenced the interface design and the implementation of the application.

The *specialised issues* addressed were:

- differences between experienced and non-experienced authors concerning the approach used for authoring.
- the influence of the application's size on the approaches used by the authors.
- if there was a relationship between the authors' role and the authoring approach they've used.
- if authors considered context-dependent links as well as typed links important for conveying information to the learners.
- if authors structured the information using different levels of granularity.

4 Results and Discussion

4.1 Results for the General Issues

a) Was there a general method/methodology for the authoring of hypermedia applications for education ?

We cannot affirm that there was a general method/methodology if we consider the strict definitions of both words. But we can affirm that we found general guidelines. Among the applications, twelve were developed by authors who designed in the first place the structural knowledge for the domain and then looked for resources (references, images, videos, sound, etc.). Seven were developed by authors that alternated between the structural knowledge's design and the search for resources and only one was developed by authors that looked for resources before designing the structural knowledge.

Eight authors answered that there was not a common way that could be used to structure any domain. Three answered that it could be the same when considering the same domain and two answered that it could be the same for any domain. Twelve authors, almost the totality, answered that there was not *the best way* of structuring the domain, from the readers' point of view. These results were expected since the structure is influenced by many different variables such as the educational goals, the author's understanding of learning and teaching, the social as well as the cultural contexts in which the author is inserted, to mention some.

b) What are the differences and similarities between the cognitive writing processes used in the development of hypermedia and non-hypermedia applications for education ?

Seven authors used a top-down approach. Among these, four authors have already developed more than one application and only one out of these four used a different approach on the development of her first application. All the others used a top-down approach for the first and subsequent applications. The top-down approach was used in three different ways: subdividing the domain into different areas - two authors; using a Table of Contents - one author; and defining a hierarchy of concepts - four authors.

Six authors used a mixed approach. The mixed approach is also described as one of the possible mental processes commonly used [Hayes & Flower, 80], [Nanard & Nanard, 95].

Only one author used a bottom-up approach for the first application developed. The bottom-up application was small and at that time the author had only read about hypermedia. For the development of hand-crafted applications little planning is required since all of the information can be kept in short-term memory.

An interesting point to mention is that *all the large applications* (four) were developed using a top-down approach. Among these, three were developed by non-experienced hypermedia authors - two with the role of managers and one with the role of developing everything. One large application was developed by an experienced author whose role was to develop everything.

c) Were the links *essential* when structuring the knowledge domain?

Ten authors, almost the totality, answered that the link information was **not** essential when structuring the knowledge domain. Among these, half had already developed at least one hypermedia application for education beforehand and four were the authors of the four large applications considered in our sample data.

Two authors answered that the links were essential and one answered that it was dependent on the educational goals.

This result reflects that the development of a hypermedia application should neither be constrained by the links available nor by the "hypermedia style", as Stevan Harnad [1] pointed out (personal communication): "You can improve the discursive text by adding hypertext links, but to make the discursive text written with hypertext in mind, forcing it into hypertext moulder of any kind, is going to make it worse. At least, the good ones".

d) Is it important to represent the author's cognitive map in the structure of the application and do learners need to know it in advance?

Eight authors, almost two-thirds of the sample used, answered that it is important to represent in the structure of the hypermedia application the author's cognitive map for the knowledge domain. Three answered that it was not important and two answered that it was dependent on the educational goals. Nine authors, more than two-thirds of the sample used, answered that learners needed to know in advance the author's cognitive map for the knowledge domain. Three answered that it was not necessary and one answered that it was dependent on the educational goals.

e) Could the development be divided into different phases and groups?

Eight authors answered that the interface design, the structural knowledge design and the authoring of the nodes' contents can be done separately. Among these, six answered that it is possible if there was constant interaction among the groups and two answered that it was possible even if the interaction occurred only at the end of the development.

Two of the three authors involved in the development of large applications answered that the development could be split into different phases and groups. Four authors answered that the structural knowledge design and the authoring of the nodes' contents should be done by the same group.

Interaction was the word mentioned by eight authors, two-thirds of the sample used. It could happen at the end or be a continuing process, but it should happen. The results were very important since large-scale hypermedia applications can very rarely be developed entirely by the same group. It may involve the sharing of tasks among different groups, departments, universities and even countries.

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[1] Professor Stevan Harnard is the Director of the Cognitive Sciences Centre at the University of Southampton

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f) If there were commonalties among the resources used?

The resources used and the number of authors that used each one [Tab. 1] reflect the kind of applications being developed at the University.

Resources	Authors	Resources	Authors	Resources	Authors
Text	13	Glossary	3	Summative assessment	1
Images	9	Databases	2	Thesaurus	1
Keywords	6	Dictionary	2	Index	1
Different SW for the interface	6	Simulation	2	Tutorial for beginners	1
Multiple-choice exercises	5	E-mail	2	Abstracts from papers	1
Video	5	Animation	1	Biographies	1
Web URLs	5	Archives	1	Spreadsheet	1
Search by Content	4	Quizzes	1	Graphic Tool	1
Diagrams	3	Tests	1		1

Table 1 - Resources used

g) What was the most commonly used instructional approach?

Eleven applications, more than a half, were developed using problem-solving as the instructional approach. Seven used an exploratory/research approach and two used drill and practice. It is important to mention that among the four authors involved in the development of applications using an exploratory approach, three have answered that the author's cognitive map should be present in the structure of the application and that learners should know this cognitive map in advance. The results show that hypermedia applications for education are more than just encyclopaedias where the students have to explore freely the contents in order to learn. To develop a hypermedia application as encyclopaedia is to forget the existence of the context in which learning takes place. And the context is one of the fundamental tools for education [Whalley, 93], [Simon, 95].

h) How were the applications introduced in the courses?

Sixteen applications, four-fifths of the total number of applications, were used to complement classes, two were used as a substitute and two were used either to complement classes or as a substitute for classes. This analysis shows that authors are not developing hypermedia applications to substitute their classes. The applications are mostly being used to complement classes, so they can enhance learning. The authors that developed applications to be used as a complement to classes had either of two objectives in mind: the application be used in a way to reinforce the knowledge learnt during formal classes or to allow learners to practice the concepts presented in the classes.

i) Did the authoring tool used influence the interface design and the implementation of the application ?

Our objective was not to evaluate or even compare the authoring tools used but to find out generally the influence of the authoring tool on the design of the interface and implementation. All the authors of our sample either used the Web or Microcosm [Davis et al., 92] as an authoring tool. Some authors used a front-end software (Assymetrix ToolBook or Microsoft Visual Basic) on top of Microcosm to design the interface. The only issues considered [Tab. 2] were the ones mentioned by the authors, since there were no suggestions provided.

Issues	Authors	Issues	Authors
flexible to incorporate other software	2	restrictive concerning the interface	4
good searching mechanism	1	no flexibility	4
flexible in general	4		

Table 2 - The general influence of the authoring tool

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4.2 Results for the Specialised Issues

a) Were there differences between experienced and non-experienced authors concerning the approach used for authoring ?

All the four authors that did not have any previous experience in the development of hypermedia applications used a top-down approach.

Among the authors that have only read about hypermedia before developing their first application, two used a top-down approach, one used a bottom-up approach and three used a mixed one.

Among the seven authors that have developed at least one hypermedia application for education three used a top-down approach and four used a mixed one.

The top-down approach was chosen by the majority of authors, independently of their role.

b) Did the application's size influence on the approaches used by authors?

All the large applications, four in total, were developed with a top-down approach to authoring.

Among the ten medium size applications developed, half were developed with a top-down approach and the other half with a mixed approach.

Among the six small applications, half were developed with a top-down approach, two with a mixed approach and only one with a bottom-up approach.

The bottom-up approach was used only once, considering the twenty applications of our data sample. Almost all the applications were developed using either a top-down or a mixed approach. This result shows that planning is fundamental for the development of applications, either in the beginning of the development or as an iterative process.

c) Was there a relationship between the author's role and the authoring approach used?

We did not find a significant relationship since in all situations the majority have chosen either a top-down approach or a mixed one.

d) Did authors structure the information using different levels of granularity ?

All the authors used different levels of granularity for the information they structured. This result shows that it is fundamental to impose some levels of abstraction in order to help the learner.

e) Did authors consider context-dependent links as well as typed links important for conveying information to the learners ?

Nine authors, more than half of the sample, considered it important to use context-dependent links. Four did not consider contextual links important.

Nine authors, more than half of the sample, considered typed links important to conveying information to the learner. One author answered that it was dependent on the kind of application. Three authors did not consider typed links important.

5 Conclusions

Hypermedia authoring for education is a very complex task. Authors have to consider many different variables, all important and interrelated: the design of the domain's structural knowledge, the instructional theory to use, the educational goals, the learning theory upon which the instructional theory is based, any instructional design guidelines, how the application will be used in the course, the hypermedia tool available for the interface design and implementation, the interface design, which links to define, and how to organise the information for novice as well as experienced learners.

The main results are:

- It is important to keep the context when developing applications with educational purposes
- The top-down approach is widely used as a way of planning, organising thoughts and structuring the knowledge
- Authors' cognitive writing processes remain the same when considering hypermedia authorship
- The authoring tool is a key point in helping the authoring process, specially when considering large-scale applications
- Authors, at least at the University, use hypermedia applications as a complement to their classes.
- Cognitive maps, contextual links and typed links are important for knowledge structuring and for Conveying local as well as global coherence to learners

Our purpose is to help authors in the development of good quality hypermedia applications for education. To do so we are undertaking a research project called SHAPE. The empirical study presented in this paper is one of the sub-products of the project and is aimed at investigating the processes involved in the authoring of hypermedia applications for education.

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Categories of Computer Use and Their Relation With Attitude Toward Computers

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Abstract: This paper reports the relationship between computer use and attitudes toward computers. The results from three surveys demonstrate that there are several categories of computer use among students and their attitudes towards computers is related to the categories of use. These differences and relations have possible far reaching implications for institutions which are planning widespread computer implementation in teaching. If the students have a negative attitude towards computer use, it could impact their level of use of computers. That, in turn, can have an impact on learning and the way the learning process changes with the adaptation of computers.

Introduction

With the increasing use of technology in education and training it is becoming important to assess the relationship between attitudes towards computers and the level of usage of computers. In the past these questions were relatively standardized and both attitudes and usage could be measured with standardized tools. Particularly in the case of attitude towards computers, tools such as the Computer Attitude Measure (Kay, 1989) and Attitudes Towards Computer Usage Scale (Popovich , et., al. 1987) included a set of standardized questions that measured how users felt about computers. However, with the increasing sophistication of computers, and early adaptation in schools both the patterns of usage and attitudes are bound to change. In the past, usage was measured primarily around the issues of temporality, instruction and applications. In the case of temporality, the focus was on measuring the length of time an user would have used computers. For instance, relations were drawn between the length of usage and attitudes just as differences in opinion were studied between fresh users and experienced users (see, e.g., Gustafson, 1992; Okebukola, et. al, 1992). In a similar fashion the issue of attitude and its relation to instruction has been examined as well. Instruction has most often been defined as the amount of formal training an user has received in the use of computers. As in the case of new users and experienced users, the amount of training has often been different leading to differences in attitudes and perceptions. Often instruction and application coalesce together where researchers would combine the component of instruction with application which refers to the breadth of computer usage in terms of the software the user executes on the computer. For instance, specific software applications have been studied and relations have been drawn between specific applications and resulting attitudes (see, e.g., Wu and Morgan, 1989; Chen, 1985; Kay, 1992; Igbaria et., al., 1995b).

Based on the past research what becomes clear is that there has been an interest in the assessment of the relation between computer usage and attitude towards computers. As pointed out by Kay (1989) this is based on fundamental assumptions about attitudes, beliefs and behaviors as suggested by Ajzen and Fishbein (1980) in their seminal work on the relationship between attitudes and the prediction of behavior. Consequently there have emerged several attitude measurement scales and procedures (see, e.g., Richards 1986; Kay 1992; Kay 1989; Abler, 1985; Loyd and Loyd, 1985; Pinto, 1985; Bannon, 1985). There has, however, been little agreement about any standardized scale that can be used in a generalizable fashion. We argue that is the case because of increasing fragmentation of computer use, and the resulting differences in the ways in which computers are being used. It is not only difficult to develop a standardized scale but also difficult to categorize usage on the basis of length of use, training and application-centered analysis alone.

In this paper we argue that it is important to consider the variety of uses that potential and existing computer users can have, particularly in the educational setting of an undergraduate college. However, that use is not measured in terms of experience, training or specific applications. In stead, use is measured in terms of the specific tasks that the computer is used for. Further, this paper explores the relationship between the specific task based use of computers and attitudes towards computers. There are thus two key exploratory research questions that are raised:

1. What are the specific tasks for which computers are used in undergraduate education?
2. What is the relationship between specific task-based use and attitude towards computers?

Methods

Procedure

The survey was administered during the registration period to all the students enrolled at the University. There was only one attempt at collecting the data. The questionnaire used for the survey was the product of a set of focus groups with members of the population. These focus groups yielded valuable information about the key issues facing the students of the specific University which was in the initial stages of a massive reorganization of its computer infrastructure that included a long-term contract with a major international computer company that would be providing all students at the University with a mobile computer. This survey, a part of a longitudinal study, was conducted a year before the standardized computers were to be made available to the students. Participation in the survey was voluntary and an overall response rate of 38% was obtained.

The questionnaire was four pages long with several sections. The first of these sections dealt with attitude towards computers. There were a total of 24 attitude items of which several dealt with the specific aspects of the computerization initiative taken by the University. There were five items that dealt with general attitudes towards computer use. The attitude measures all consisted of five-point Lickert-type items (Strongly Agree, Agree, Not Sure, Disagree, Strongly Disagree). In a similar way, the usage questions consisted of 11 four-point Lickert-type items (Very Frequently, Frequently, Infrequently, Never). Other subscales included the measurement of the factors that affect the teaching effectiveness of computers, frequent communication activities (e.g., face to face communication with teacher, etc.) of the students, and demographics. The latter was made up of self-perception of computer expertise, gender, school year, income, ethnicity, and citizenship status.

Sample

The entire population of the University were given questionnaires and at the end of the registration period a total of 1,444 surveys were returned (52.6% male, 47.3% female), ranging in school year from freshman to senior with 32.1% being freshmen, 25.3% being sophomores, 20.3% being juniors and 22.3% being seniors. All the major disciplines at the University were represented with 25% claiming a science or math related major, 28.3% claiming a liberal arts or social science related major, 14.7% claiming a business major and 2.5% claiming a fine arts related major. The average household income of the students was reported in the range of $81K and above with 37.4% of the respondents reporting an average household income of $101K and above. Finally, 89.4% of the respondents were white with 6.6% being African-American and the remaining 4% being distributed between Asians (2.4%) and other ethnicities.

Research Design and Method of Analysis

The means, standard deviations and internal reliability coefficients were determined for the five item subscale for the general attitude towards computers. A principal component factor analysis, followed by varimax rotation of the factor solution was used to determine the four primary uses of computers. This was followed by a re-coding of the usage measure into dichotomous (high and low) variables. Students t-tests were performed along with tests of homogeneity of variance of groups to test for significant difference in attitude between high and low users. Finally, linear regression analysis was conducted with levels of usage as dependent variables and attitude as independent variables to test for the relationship between attitudes and the predicting power of attitude measures.

Results

The means of the attitude measurement scales fluctuated from 2.80 to 3.47. The standard deviations for individual attitude items ranged from 0.98 to 1.21 (Table 1). The alpha coefficient for the attitude scale made up of the five attitude items was 0.69. The mean of the usage measures varied from 3.56 to 1.54 with standard deviations ranging from 0.68 to 1.26 (Table 2). The alpha coefficients for the three subscales of task based Network use, non-task Network use, data management and mathematical computing were 0.57, 0.73, 0.67 and 0.71 respectively.

Table 1: Mean and Standard Deviation for Attitude Towards Computers Measure (N=1,444)

Item	Mean	S.D.
1. Increased use of technology in teaching makes learning easier	3.47	0.98
2. The introduction of computers to teaching is too rapid	2.90	1.02
3. I feel comfortable using computers	3.57	1.12
4. I have a certain apprehension about computer use	2.80	1.21
5. Computers in teaching makes the learning process too impersonal	3.17	1.04

Table 2: Mean and Standard Deviation for Usage Measure with 1 = Never, 4= Very Frequently (N=1,444)

Item	Mean	S.D.
1. Using the Internet to get information	2.83	1.02
2. e-mail with friends	3.40	0.90
3. e-mail with family	2.31	1.26
4. e-mail with classmates	2.57	1.09
5. e-mail with teachers	2.16	0.92
6. e-mail with student organizations	1.79	0.95
7. Statistical computing	1.54	0.76
8. Mathematical computing	1.66	0.85
9. Spreadsheet	1.60	0.85
10. Database management	1.56	0.81
11. Word-processing	3.56	0.68

The principal component factor analysis produced a four factor solution accounting for 68.7% of the total variance. The varimax rotated factor loadings greater then 0.40 are shown in Table 3. Each of the four usage subscales produced a relatively distinct and cohesive group.

Table 3: Varimax Rotated Factor Loadings for Usage Measures

Subscale	Item	Factor 1	Factor 2	Factor 3	Factor 4
Net use for non-task activity					
	Using the Internet to get information	0.48			
	e-mail with friends	0.81			
	e-mail with family	0.78			
	e-mail with classmates	0.59			
Net use for task activity					
	e-mail with teachers		0.67		
	e-mail with student orgs.		0.83		
Mathematical Computing					
	Statistical Computing			0.77	
	Mathematical Computing			0.88	
Data Management					
	Spreadsheet				0.78
	Databases				0.84

The pooled variance t-tests with low and high users in each of the five categories of usage yielded significant differences between the means of each of the attitude measures at $p < 0.001$. The means for each group are shown in Table 4. The cell size for each group is also reported in the table. Given the unequal cell sizes, tests of homogeneity of variance were conducted for all the t-tests and in none of the cases were the variances found to be significantly different.

Table 4: Difference between Attitude Item Means Based on Low and High Usage (numbers in parenthesis indicate N)

	Net 1	Net 1	Net 2	Net 2	Math	Math	Data	Data
	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi
1	3.38(947)	3.66(435)	3.15(303)	3.56(1066)	3.42(1176)	3.75(198)	3.42(1150)	3.73(230)
2	3.02(949)	3.25(436)	2.81(303)	3.18(1070)	3.06(1180)	3.36(198)	3.05(1154)	3.33(230)
3	3.44(947)	3.83(435)	3.00(300)	3.73(1070)	3.49(1179)	4.01(196)	3.45(1151)	4.11(230)
4	3.11(947)	3.37(431)	2.73(298)	3.33(1068)	3.11 (1176)	3.64 (195)	3.09 (1151)	3.71 (230)
5	2.78(950)	2.94(433)	2.52(303)	2.92(1068)	2.78 (1181)	3.12 (195)	2.77 (1154)	3.14 (228)

Finally, all correlation between each of the attitude scales, the summed attitude scale and the usage scales were found to be positive and significant ($p<0.001$). The correlation coefficients are shown in Table 5.

Table 5: Correlation between attitude measures and usage measures

	WP	Data management	Mathematical	Net for Non-Task	Net for task
Multiple R for all attitude items	0.17	0.25	0.20	0.31	0.19
Item 1	0.10	0.17	0.15	0.23	0.15
Item 2	0.11	0.17	0.13	0.22	0.14
Item 3	0.20	0.29	0.23	0.36	0.21
Item 4	0.14	0.24	0.19	0.25	0.15
Item 5	0.11	0.17	0.15	0.19	0.10

Discussion

The purpose of the analysis of the survey data was to explore the different modalities of computer use and then seek any relationships that might exist between the categories of use and attitude towards computers. The results suggest that there are distinct categories of use as well as significant relationships between categories of use and attitudes. The sample for the study was sufficiently large and diverse to lend statistical merit to the results. The item standard deviations were relatively consistent for both the attitude and the usage measures. Furthermore, the high alpha coefficients for the attitude measures as well as the usage subscales suggest high internal reliability.

First, it is clear that there are four specific areas of computer use for different tasks. As demonstrated by the factor analysis, college students use computers for five main tasks. This suggests that when considering the concept of "usage" it is necessary to distinguish between different kinds of use. Secondly, this is all the more important since the findings suggest that there are significant differences in attitude of the high and low users in all categories of use. In general, low users of computers tend to have a more negative attitude towards computers. However, the difference is most marked in the case of the items "I feel comfortable using computers" and "I have a certain apprehension about computer use." For instance, the difference in attitude means on the first item was 0.73 between the low and high users of the Network for task purposes. Similarly there was a difference of 0.66 units for the same item between low and high users of data management programs. On the other hand, the difference on that measure was least (0.39 units) for low and high users of the Net for non-task purposes. This would suggest that students are often forced to use the computer for task purposes even when they might have a negative attitude towards computer use. Conversely, those students who have a positive attitude tend to use the computers more for task purposes. This is further borne out by the low correlation between summed attitude items and computer use for task purposes. This indicates that the variance in computer use for task purposes is minimally explained by attitude and is perhaps better explained by the fact that students are forced to use computers in some classes. This could suggest that students use computers for task purposes because they are forced to do so and not because they are interested in computers. On the other hand, the higher correlation ($r=0.31$) between summed attitude items and Net use for non-task purposes suggests that those who have a positive attitude towards computers readily use it for non-task purposes.

Conclusion

Based on the results of the 1,444 surveys it is clear that there are several categories of computer use among students and their attitudes towards computers is related to the categories of use. These differences and relations have possible far reaching implications for institutions which are planning widespread computer implementation in teaching. If the students have a negative attitude towards computer use, it could impact their level of use of computers. That, in turn, can have an impact on learning and the way the learning process changes with the adaptation of computers. While it has been known that there is a relationship between computer use and attitudes towards computers, the results reported here demonstrate that computer use is not a monolithic and singular construct. Indeed it is a multi-dimensional element and there are different relationships between categories of use and attitude towards computers. These different relations need to be considered when computers are used in teaching.

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Teaching Natural Sciences in Primary Schools: the Role of a Museum

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Abstract: This work describes how hypermedia and network technology can contribute to creating a Distributed Open Learning/ Teaching Environment. In particular, we present a case study of teaching natural sciences in primary schools with a didactic itinerary, called 'The Mammals', which was designed and developed by the Natural History Museum of the University of Pisa. We outline the psycho-pedagogical basis of the project, along with organisational aspects, operating tools, project criteria, and the electronic and computer support.

1 Introduction

The Natural History Museum of the University of Pisa (henceforth, the Museum) has long been interested in didactic problems, and in the role museums can have in education on a local scale [Boni. 91, Fran. 91, Zuff. 91]. The Museum has been particularly interested in designing didactic itineraries, such as Mammals and Amphibians, in order to enhance the intellectual development of primary school children. In fact, the Museum has recently planned to install a computer network (EnviNet Project, [Sbrana.95]), promoted by the local authorities and aimed at building a network of centres for environmental education within Tuscany. Our work has been to provide hypermedial and network communication support for this Distributed Open Learning/ Teaching Environment, in which relevant didactic concepts could be integrated and expanded through extra-mural visits, presentations and experiences with other museums, natural parks, laboratories, scientific observatories, etc. Within the EnviNet project a laboratory on environmental education will be created at the Centro di Documentazione e Ricerca Educativa of the Provincial Administration of Pisa plus four other related centres (all connected by the same computer network).

Section 2 outlines one particular didactic itinerary, the Mammals, which was designed by the Museum for primary schools, and which fits into the general framework of museum/school integration in natural sciences and environmental education. Section 3 analyses the rationale behind the project for introducing computer and electronic support for teaching, and details some aspects of the solutions that have been implemented.

2 The Mammals - A didactic itinerary

Below we summarize the fundamental psycho-pedagogical and structural aspects of the Mammals itinerary, which was designed by two of the authors of the present paper, Berni and Zuffi, who have primary school teaching experience alongside research in zoology at the Museum. For further details see [Berni.96].

2 a Psycho-pedagogical basis of the itinerary

The main aim was to help children to understand, in this case through observing the skeletons of 10 species of mammals, the relationship between the variances found and the functional adaptation needs to the environment. The starting and reference point is a human skeleton, ie the skeleton of the children themselves. This is used to show the children how they perceive it and how they schematize such perceptions. The children then compare this human skeleton with the skeletons of the mammals, again on a perception/sensory level. This enables them to hypothesize on why changes have come about in the structure of the various mammals.

Understanding how and why mammals diversify and are transformed as a reaction to the environment, helps children to focus on natural processes (above all in the animal world), and offers a dynamic perspective on the interactions between life environments and the physical characteristics of the organisms.

The itinerary is based on three main factors: (i) establish what the children already know; (ii) limit the work to mammals, specifically those which can be compared to a basic skeleton structure (10 animals); (iii) get children to give plausible explanations for these variations in terms of function, and adaptation to the environment, without any quantified time references.

This rationale entails radically altering the traditional approach to museums, where visiting classes are accompanied by an 'expert' who imparts knowledge, often in overly technical language, with questions being left to the end. Instead in our case, it is the children who ask the questions from the outset, the role of the expert being to guide the children in their discovery of the distinctive properties of the various mammals.

The underlying concepts of this didactic itinerary derive (i) from Piaget's ideas [Piaget. 66, 73] on the formation of thought in children, and later studies on its 'magic' tendency [Donald.79], (ii) from research into conceptual maps in children's thought [Pontec.86], and (iii) from studies on preconceived ideas that may condition learning [AA.VV.85,.89, Berni.89]. A child's preconceived ideas on any subject covered in a syllabus must be known, so that teachers will ask the 'right' questions. In answering, the child will objectify his/her knowledge and will thus interact with the subject of learning. This interaction should modify any erroneous preconceptions, thus leading to a correct, stable, and lasting knowledge. When children are free to test out their own ideas and to compare these ideas with their companions they will be able to build their own social knowledge. In this case the teacher takes on a new role as stimulator and mediator. Back in 1954 Dewey had already envisioned this as the role of the teacher in an 'active school' [Dewey.54], even though this was only an intuition that was not objectified by the psychological processes with which child learning takes place.

2 b Didactic structure

Below is the framework of the activities of the didactic itinerary [Berni 96].

Objective:	*distinguish between mammals and non mammals*
Activity	children (i) divide pictures of animals into sets of mammals and non mammals using their own reasoning; (ii) compare criteria underlying their selection; (iii) if necessary, integrate their knowledge with simple information
Objective:	*find out which animals were really recognised by the children*
Activity	children (i) write a free list of names of the animals (mammals and others) that they claim to know; after some time, (ii) teacher gives the list back to the childs, and (iii) get them to write down what each animal eats and where it lives
Objective:	*investigate what perception children have of their own skeleton within the body scheme*
Activity	children (i) do a spontaneous and free drawing (without giving them any clues); (ii) get children to touch their body, telling them verbally which specific parts to touch, children now (iii) do a spontaneous and free drawing; (iv) use physical exercises so that children get a better perception of how their bodies are articulated; (v) children draw a skeleton, within the outline of a human body, on the basis of knowledge learned in the above physical exercises

Stage 1: External exploration Visit to the Natural History Museum for an initial contact with the 10 animals and some first hypotheses on changes and variations in their structure.

Stage 2: Internal exploration Children's knowledge of around 10 animals is compared to form the basis of Venn and Carrol diagrams founded on a 'similar-different' relationship. Reproduction, behaviour with offspring, nutrition, and habitat are considered especially in terms of internal structure vs external coating (ie the relationship on which the Museum is organised).

Stage 3: Cognition Children fill in three worksheets regarding the animals. The first sheet is filled in either individually or in pairs, and uses questions to guide children in observing physical and functional characteristics. The second sheet is read collectively, and gives information on the animals habits, habitat etc.; children can make comments and additions at will.

Stage 4: Revision Continuous revision using diagrams on the basis of new information on the animals.

Stage 5: Control Second visit to the same sections of the museum. Children meet with expert who gives information, settles curiosities, answers questions, and resolves any problems that came up in the first visit. The relationship between expert and visitor is traditional; this is a control stage since from the type of questions that the children ask, their level of attention, motivation and interaction can be assessed. Teachers should be arousing curiosity without answering the resulting questions.

Stage 6: Verification Children complete five worksheets: 1) children separate mammals from non mammals; 2) from a given number of possibilities, children identify the characteristics of a mammal's skeleton, and freely describe the behaviour of mammals towards their offspring; 3) children distinguish a mammal's skeleton from a non mammal's, giving explanations; 4) children locate some mammals, on the basis of their habitat, in some Carrol diagrams (cfr. [Rinaldi.85]); 5) for the 10 given animals, children identify what has changed in the internal/external structure and give plausible hypotheses on the reasons for such changes.

3 Project analyses and choices

This section outlines the rationale behind the project, for further details see [Berni.96].

3.1 Network Communication Support

In the Introduction we stressed the opportunities for contact enabled by having a Distributed Open Learning/ Teaching Environment which can be exploited by schools. On the other hand, in Section 2a, we also noted that the main features of the Mammals itinerary significantly alter the traditional roles of visitor and expert in a museum. This 'discovery' concept can already be seen in the preparatory stage before the first visit, when teachers limit themselves to a stimulator-mediator role. It is then furthered during the visits, particularly during the first when there is no expert present. Yet, at the same time, teachers have to deal with the fact that their own role has been radically redefined, and they too, to some extent, go on their own voyage of discovery. This naturally conditions how the itinerary should be organised, and what teacher support should be given, both in terms of the original didactic project and in terms of hypermedia and new network communication support tools.

The procedure in the original project

In the original didactic project there is a preliminary meeting between the authors of the project itself (Berni - Zuffi) and the teachers that are interested in testing it out in class. The psycho-pedagogic importance is outlined, along with the goals, methodology, activities scheduled, and the cognitive aspects relating to the biological world via an analysis of the morpho-functional differences of the mammal species under consideration.

At further meetings, teachers are given support for adapting the project to their class syllabus, and for going into cognitive aspects regarding animals. They are also helped in assessing and quantifying the data that emerge from the children's activities. Information and materials regarding the itinerary are exchanged, and teachers are encouraged to take children to see the animals they are studying in their natural habitat. Particular care is taken in preparing teachers for the first visit to the museum (when there is no expert present), in terms of what role the teacher should play and what questions the children should be asked, alongside practical information about where and how the animals are displayed in the museum.

The new procedure using network communication and hypermedia tools

Most of the initial preparation work before the visits to the museum can be based on hypermedia support and interactive exchange over the Internet. This includes most of the information, explanation and preparation phases of the teachers, leaving direct contact only to essential aspects. In fact, the Museum is planning to set up its own www site with the usual services (e.mail, WWW, FTP, Gopher etc) alongside the availability of some stations with external ISDN/H.320 connections, so that an A/V point-to-point communication environment can be made with similarly equipped stations in schools [MultiLab.95], via interactive telematic functions (ITF). Below is a brief summary; see [Contat.93] for further details.

Some examples of essential Interactive Telematic Functions (ITF)

audio talk	via phone talk directly to the person you're connected with (hereafter User 2)
video talk	see User 2
whiteboard	share your screen with User 2, and draw, call up images etc
shared applications	share applications in real time, allow User 2 to use applications in execution on your station, specifying which ones can be used. For example, User 2 can write documents on a word processor that is only available at your station.

These functions can be used by museum staff to interact with teachers in the organisation of didactic activities and class visits. In particular, for: (i) selecting didactic itineraries and preparing visits for particular users, eg schools, classes, environmental groups, nature club groups; (ii) preparing visits, plus carrying out the visits themselves, which as we have already mentioned, may be 'discoveries' for the teacher/group organiser; (iii) processing materials arising from the visit, such as producing reports, drawings (or in the case of extensions to middle and high schools), student to student interactive collaboration via the Internet. See [Berni.96] for primary school experiences with the Natural History Museum of Pisa, and [Carafa.96]) for middle and high schools.

This multi tool and multimedia solution saves considerably on time and organising loads. It also leads to greater autonomy, flexibility and operating efficiency both on the part of teachers and museum staff.

3.2 Hypermedia Support

When designing and developing the hypermedia support, we drew on the experience from the world of the environmental and cultural assets and also on various didactic applications developed at the Computer Science Department of the University of Pisa [Albe.95], in particular with reference to education on the environment [Lagana.95]. We organised this support into three sections: Tutorial, Mammals, and Worksheet Collection. These sections are strongly connected and integrated in their communication and hypermedia functionalities.

3.2a Tutorial This hypermedia is used to acquire knowledge on the various parts of the Project, aims and methodology; and to display the activities scheduled for the students, thus facilitating an intuitive and exemplification approach to the original project. This can be reduced to a few significant pages that can be easily accessed and read directly on the Internet. This section is for informing teachers, and for museum experts to spread information.

3.2b Mammals This is the most important section since it supplies the main support for the didactic project as a whole, and it resolves the interactions between the three main entities involved (Provincial Administration, Museum, and Schools). It is fully computerized and is primarily intended for schools, who can not only carry out didactic activities but also send and receive data and results. It can also be supplied to the Museum, where it should only be used for reception and to support interactions between all three components. Teachers can exclude or add animal worksheets. Schools with the same application can communicate with each other and exchange worksheets, images, comments, etc. Teachers can also file activities carried out by their students, which they can then consult, thus facilitating any assessment or quantification of such data.

3.2c Worksheet Collection This section is for collecting data on how the itinerary is going. Verification can be on two subjects:

1) children - directly on the their level of learning, via the completion of worksheets that establish the base knowledge on certain subjects (initial test) and then the worksheets relating to the contents and methodologies adopted during the execution of this didactic unit (final test);

2) teachers - via a questionnaire which finds out the level of satisfaction with the project, with some notes on changes that could be made to make the project itself more functional, with discussion and comparison of any modifications/customizations made in class.

The Museum already has data from various verification sources to assess the progress of the didactic activities. The data on pupil activities are collected in table form. The section on Worksheet Collection is used by the Museum and by the Provincial Administration, and supports School - Museum & School - Provincial Administration interactions. In that particular case, tables with students' marks are exchanged.

3.3 Detailed description of hypermedia support

When choosing the system to develop the hypermedia support our main criteria were simplicity, interactiveness, and diffusion in the school environment in order to facilitate use and so that teachers could easily make their own modification. We thus used a PC/Windows environment, equipped with a Multimedia Toolbook, version 3.0 [Asym.94], trying as far as possible to be coherent and intuitive. Within the hypermedia films, animations, and 3D scenes can be shown, which are particularly stimulating for children.

There are two levels of use. 1) Pupil - for carrying out the varies activities scheduled in the project. 2) Teacher - for (i) checking pupil's work, (ii) making personal notes on such work, and (iii) authoring, thus enabling teachers to choose the animals, to go onto the pupils' worksheets, and to create new worksheets on animals not scheduled in the project. Teachers can also use the Internet directly from the application.

3.3.a The Tutorial The *Tutorial* consists of a book (in tbk), which is a user manual that illustrates the project step by step with guidance on how to use the multimedia part. To make the book as clear as possible it is equipped with images, animations, sounds, and most important, hypertextual links. The photos for use in class for the perception of the human skeleton and the photos of the animals in the Museum are not contained in the Tutorial but are stored in .bmp in a subdirectory and can be called up when required. The animations regard above all explanations of some pupil activities, and give a much better idea of how activities should be carried out than would have been possible with written text. The sounds are used for special effects during the animations and as background music. They can be called up at any moment via a dialog window. The music is basically clips created with the Toolbook and stored in a subdirectory for use as required.

Teachers can click on a hotword to get hypertextual links, and audio-visual support by clicking on parts of the text or images contained therein. At any moment teachers can visualize a map which shows them what they have already read (even if not in sequential order), where they are up to in the general map, and where they can re-enter.

3.3.b Mammals The application was designed and developed so that at a later date other institutions involved in Environmental Education in this geographical area could also interact (Parco di Migliarino-S.Rossore-Massaciuccoli, WWF, LIPU project, holiday farmhouses, etc, and via the Laboratory of environmental education, with "Andrea" data [Andrea.95] and with the whole "world" of the Labnet Project, which for some years has been fully active throughout Italy). Both the functionalities that exploit EnviNet and those services that use ITF were implemented into the application and can be used via dedicated user friendly interfaces.

- **Student level** Bearing in mind the activities, the operating phases, and the worksheets outlined in Section 2b, we will now describe how the pupil activities were developed. Each piece of classwork is recorded in the database so that it can be looked at again at a later date.

1st animal list. The list is compiled via a field equipped with a scroll bar where the list can be written.

Maze game. In this game children find themselves in front of a maze in which there are animals - mammals and non mammals. The aim of the game is to follow a path along which there are only mammals. This is not that simple since when the child makes a mistake he/she is not warned of this immediately but only at the end. The result of this activity is not stored since it is not considered as an activity that can be retrieved either by the teacher or pupil.

Formation of sets The page on which the activity takes place shows two sets, one for the mammals and one for the non mammals, and a number of animal icons with the name of the animal underneath. Pupils have to drag each icon (known as the source) into the correct set (known as the destination) - this is a drag and drop functionality of the new Multimedia Toolbook. We ensured that the image associated with each animal icon (source object) was identical to the icon itself, so that the cursor doesn't change shape during dragging.

Skeleton colouring. On one side of the page is a complete human skeleton and on the other side a dismantled skeleton. Pupils have to colour (using a colour palette) the skeleton parts using the same colours as in the complete skeleton.

2nd animal list The page shows three adjacent scrollable fields which are synchronized in their scrolling: (i) the first shows the list written by the pupil while carrying out the *1st animal list*; (ii) the second and the third are to fill in with information regarding 'what it eats' and 'where it lives', respectively.

Cognitive worksheets. There are three worksheets for each animal, each with photos (zoom option available). The first and third are easy for the pupil to fill in by writing their observations, the second is purely informative and is in text form. For some animals we have created an extra worksheet which is used as an introduction to the other worksheets. There are only a few 'verbal-written' components, while it is possible to show animations (sometimes in 3D) or a short film or photo in which there are hot points which the pupils can click on to get further information by text or audio comments.

Compose skeleton. The human skeleton is composed by dragging the individual elements to the outline of the human body. If the elements are not located correctly then they are automatically rejected. The pupil gets three chances, after which the positions are recorded. If the pupil gets the right result he or she is free to display the four main positions of the composed skeleton (from in front, behind, and from both sides) or to see a 3D animation which shows the rotation of a human skeleton.

Test worksheets. There are five of these: (i) the first is filled in like the one for the formation of sets, but this time it is the names of animals that are dragged into the right sets, they only become icons during dragging (ii) in the second the pupil clicks on dedicated buttons to choose the characteristics indicated, and on the other side, writes observations on the dedicated lines. (iii) the third presents pictures of two skeletons, the pupil has to identify the mammal and give relevant explanations. (iv) in the fourth the pupil collocates some mammals according to their habitat in some Carrol diagrams. This is carried out in exactly the same way as in the first worksheet. (v) In the fifth there are three scrollable fields: in the first pupils can select one from a list of names of animals corresponding to those chosen and/or added by the teacher during authoring (see below). In the second changes in the structure of the animal are written and in the third the related reasons.

- **Teacher-only activities** Teachers can choose from:

Authoring. Teachers can store and update personal data on their students, plus data identifying the class (head of school, name of school, name of class). The application can be adapted to specific didactic needs - teachers can choose which games their pupils will play, which animals to study etc. Also, they can create new worksheets and alternative paths that may be more wide ranging than the original.

Below are some details on the various options the teacher has available.

- ***Insert classes and pupils.*** The data described above (district and name of school, name of class) can be inserted, along with pointers to four tables that are created to contain data on the activities carried out by pupils in a particular class. A page then appears where the names of the teacher and pupils can be inserted.
- ***Change class and pupils*** Teachers can delete the class, delete the school that the class belongs to, modify data regarding the class. Once the changes have been confirmed they are then transferred to the tables for the class in question.
- ***Choose animals.*** This enables teachers to choose some of the animals or to create new worksheets for other animals, or to import worksheets from other users.

In this section of the application the teacher can also modify the worksheets that he/she added beforehand by correcting the text or replacing some of the images. Teachers can even delete the worksheets on an animal that was added beforehand. In this case the three pages that contain them will be deleted, and the name of the animal in question will be deleted from the list of those available.

- ***Choose game.*** Teachers can choose the games by clicking on the name of the required game, though currently only one of the two games is enabled.
- ***Change password.*** Teachers can change the password for entry into the application (ie the one for pupils) and/or the teacher's one.

See classwork Teachers can see the results of student activities. Four scrollable fields are shown for teachers to inspect - pupil name, class, school and district. The page of the activity chosen is then displayed with all the data on the work carried out by the pupil selected. Teachers can then print the result and take notes on the reports on each student, on a page which shows a dedicated 'notebook'. Teachers can obviously not change any of the pupils' work.

Tests. Teachers can put themselves to the test, using the same paths as their pupils and encountering the same difficulties.

Network At all times teachers can use Internet services directly from the application. Teachers can be connected by choosing any URL or one of those belonging to one of the four environmental education centres (cfr. [Sbrana.95]). They can also use e.mail or send worksheets via FTP to other schools that have these applications. Using an FTP program, teachers can also send images of animals to insert into the worksheets, or data on the teacher's school and classwork to show teachers from other schools.

4 Conclusions

We have shown how a Distributed Open Learning/ Teaching Environment can be offered by a museum to interact with schools. We have taken as our case study the didactic itinerary called "The Mammals" which was designed by the Natural History Museum of the University of Pisa as a support for teaching natural sciences in primary schools. We have highlighted the considerable enjoyment expressed by the teachers and students, along with the high didactic efficiency which is a result of a combination of: (i) conception of the psycho-pedagogical and didactic project of the itinerary, (ii) coordination and integration between the experts from the Museum and the teachers of the School, and thus (iii) the coordination and integration between the activities carried out by the students in class and those done at the Museum.

On the basis of these references we have outlined the criteria and modalities with which tools and suitably integrated communication and hypertextual support can be inserted into the Museum-School interaction. We have also shown the delicate relationship between Museum experts, teachers and pupils, not only trying to avoid changing the spirit of the original project, but also contributing to making: (i) the phases more flexible that are needed for the coordination, cooperation and integration between the Museum and School, and therefore (ii) the following (i.e. preparation for the visits to the Museum, visits to the Museum and classwork for the whole experience) more incisive and stimulating for the pupils; (iii) the data collection and assessment stages more systematic and organised for the teacher, for the Museum, and even for the Amminstrazione Provinciale di Pisa, which promoted the technical support for this experience.

The promising results from this experience have stimulated both the 'export' of this type of approach to other contexts of the same nature [Morreale.96], and the extension of research into wider geographical areas and including a more articulated typology of institutions that might interact with schools.

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Learning to Solve Legal Cases with the Application PROSA

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Abstract: In this paper research on legal case solving and knowledge engineering are combined to construct an explicit and principled method for instructing legal case solving. This method will be incorporated in a teaching system: PROSA. The method for instructing legal case solving is materialized as the translation of the desired task and inference structures into actions presented by the system, performed by the student and monitored by the system to provide coaching when required.

Legal Case Solving

A common method in teaching legal problem solving is to make use of (hypothetical) cases that need to be solved by the student. The main educational goal of using this approach is that students have to learn to apply legal rules to specific situations, that is, they have to learn to handle the abstract legal concepts in a concrete situation, select the applicable abstract legal rules and apply these to the specific problem situation. Research on teaching legal case solving ([Crombag, de Wijkerslooth & van Tuyll van Serooskerken 1972], [Gilltay Veth 1974], [Crombag, de Wijkerslooth & Cohen 1977], [Abas, Broekers-Knol, van Hasselt-Pino & Loenhoud-de Wolf 1985], [Henket & van Hoeven 1990], [Franken 1991], [Wessels 1992], [Tunkel 1992]) agrees on four important issues. Solving legal cases is an important way to learn legal problem solving. Secondly, students experience difficulties in solving legal cases, and law professors have difficulties with teaching legal case solving. Thirdly, the main reason for these difficulties is the lack of an explicit, teachable and learnable method and, such a method should be constructed. These observations resulted in methods for legal case solving to be used in legal education. The various methods proposed are, in essence, very much alike.

schematize the case
translate the concrete terms of the case into (abstract) legal terms
select the relevant legal rule(s)
analyze and interpret the (abstract) legal rule(s)
apply the legal rule(s)
evaluate the result
formulate the solution

To be able to provide instruction we need detailed descriptions of the specific actions in the problem solving process in relation with the knowledge to solve the problem. The literature on legal case solving does not provide us with this necessary detail. Therefor we turn to literature on artificial problem solving. [Breuker & Van de Velde 1994] present a coherent overview of computational problem solving methods described in conceptual terms. We rewrite the legal problem solving process, as proposed in the legal case solving literature mentioned above, in the terminology used in [Breuker & Van de Velde 1994].

Artificial Problem Solving

[Breuker & Van de Velde 1994] describe a collection of problem solving methods developed in Artificial Intelligence and knowledge engineering. They describe the characteristics of knowledge based problem solving. A central feature in this description is the expertise model. The expertise model expresses an understanding and rationalization of some problem solving behavior by describing the knowledge and the way it is used in a particular task. The different knowledge roles are captured in three basic knowledge categories: task knowledge, domain knowledge and inference knowledge. Task knowledge describes (1) a decomposition of the top-level task (task decomposition), (2) what it means to achieve these sub-tasks and (3) when the sub-tasks are to be executed (control). Domain knowledge specifies form, structure and contents of domain specific knowledge that is relevant for an application. Inference knowledge specifies the primitive steps in reasoning in an application and the knowledge roles that refer to classes of domain knowledge statements manipulated by the inferences.

In problem solving we distinguish (1) a problem, (2) the (or a) solution (the product) and (3) the problem solving process. The solution to a legal problem should, in general, contain a justification of the conclusion (for the sake of motivation and control). In legal case solving for educational purposes (1) the solution (product) required by the teacher mirrors the problem solving process, (2) to be able to reach a correct solution the student must be able to follow a structured problem solving process, (3) the problem solving process is expressed in terms of task knowledge, domain knowledge and inference knowledge.

The application PROSA (PROblem Situations in Administrative law)

PROSA offers support in accomplishing the (sub)-tasks. The task and inference structures are translated in actions presented by the system. The student reacts and PROSA monitors this performance. The system is able to interpret the students performance on the basis of the actions and provides coaching when required.

We illustrate the approach with a typical administrative procedural law case as used in a course on administrative law. We limit ourselves to the sub-tasks (1) schematize the case, and (2) translate the terms into the case to legal terms.

An Example of a Problem Situation in Administrative Procedural Law

A legal case is a description of a problem situation in non-legal terms, for which a solution is required from a legal perspective. A case describes a number of subjects, objects and events. The subjects and objects play different roles in the events and there are causal and teleological relations between the events. It is almost inevitable that a description is incomplete. The implicit facts and events are part of the problem situation and can be made explicit to complete the description. A criterion for a *good* legal case constructed for educational purposes is that the implicit facts and events can be inferred (almost) equally by the majority of the students.

In our example the case description is followed by a question. To solve the case is to formulate an answer to this question. In legal problem solving it is a must that the answer contains a conclusion and a description of the problem solving process.

> The municipality X has serious parking problems with trucks causing nuisance. The relatively narrow streets house many drivers, who park their trucks in these streets, especially during week ends and at night. The trucks cause many dangerous situations and are the source of complaints about noise and impediment of view. The residents of the houses in the streets where the trucks are parked have enough of it and decide to take action. They collectively write a letter (dated April 1, 1994) to the Mayor and Aldermen of X. They ask them to take suitable measures. Mayor and Aldermen answer by sending a notice in which they acknowledge receipt, state that the request is dealt with and that the residents will be informed as soon as possible.
>
> After three months the residents still did not receive an answer, they repeat there request in a letter dated July 1, 1994. On July 14, 1994, Mayor and Aldermen write that they will take a series of measures. Some of the streets where the trucks have no business, are provided with a long time parking prohibition for trucks. To be able to do that a parking excess regulation is needed. Such a regulation, however, can only be established by the city council. The letter of the Mayor and Aldermen also comes to the attention of the truck drivers. They are strongly opposed against the proposed measures. The truck drivers decide to take action. The removal firm Jansen also decides to take action. One of the truck drivers leaves it to her employer to take action. On August 15, 1994, the city council draws up a parking excess regulation. This regulation is put into operation on October 1, 1994.
>
> What actions can the truck drivers and by the removal firm Jansen take against the letter of Mayor and Aldermen dated July 14, 1994?

Part of the Task Structure for Solving a Legal Case

The sub-tasks (1) schematize the case and (2) translate the concrete terms of the case to (abstract) legal terms described in the terminology of [Breuker & Van de Velde 1994].

```
task schematize case
   task-definition
      goal: a schematized case
      input: a case description in which facts and events are explicitly and implicitly
      present in the form of an unstructured story
      output: a case description in which facts and events are explicit and structured
   task   body
      sub-tasks: complete case terms, sort case terms
      control-structures: schematize case =
      repeat
      complete case terms
      sort case terms
      until all terms are complete and sorted

task translate  case terms into legalities
   task-definition
      goal: translation of the case term into legal terms
      input: an explicit and structured case description
      output: a set of terms that are classified as legal terms
   task   body
      sub-tasks: select case term, classify case term
      control-structures: translate case terms =
      repeat
      select case term
      classify case term
      until all terms are selected and classified
```

Part of the Domain Knowledge

[Valente 1995] distinguishes types of legal knowledge, each type has its own form, structure and content and plays a specific role in the problem solving process Two important types of knowledge in legal problem solving are knowledge of the world and normative knowledge. A model of the administrative procedural law world describes the agents, objects and actions that are active in that world. For example:

```
administrative  body
: supertype [agent]
: subtype [a-body, b-body, 3-body]
: seat (string)
: status (authorized; unauthorized)
: representative (yes, no)

party concerned
: supertype [agent]
: subtype [person, administrative body, other_entity]
: interest (own; general_and_collective, objectively determinable, existent, personal, direct)
if-and-only-if            (party concerned (administrative body) )
                          than
                          (interest (own) = (consigned_interest))
if-and-only-if            (party concerned (legal person))
                          than
                          (interest ((own) or (general_and_collective))
: position (petitioner; addressee; third party_concerned)

legal act
: supertype [act]
: subtype [private_law_legal_act, public_law_legal_act]
: legal_consequence (yes)
```

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Part of the Inference Knowledge in Solving a Legal Case

To classify a case term is to use world knowledge to infer a legal term from a case term.

inference classify
  input-roles: selected case term
  out-put roles: classified case term
  static-roles: classification criteria (world knowledge)

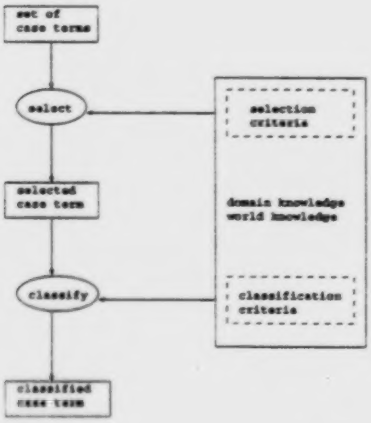
set of case terms
select
selection criteria
selected case term
domain knowledge
world knowledge
classify
classification criteria
classified case term

Figure 1: inference structure select and classify

An Example of the Interaction in PROSA

The interaction between PROSA and the student is designed on the basis of task and inference structures. These structures are translated into actions on the screen. PROSA presents the case description to the student. The first task in the task-structure is: schematize case. PROSA requires the student to perform action 1 to 4.

(1) the completion of the case description (turning implicit facts and events into explicit ones)
The system support consists of offering the case description with dotted lines in the text where something is missing in the case description. The required action of the student is to fill in these white spots.

(2) the sorting of subjects, objects and events
The system support consists of offering a table with columns marked agents, objects and actions. The required action of the student is to select a (any) term from the case description and drag it to the table [Fig. 2].

(3) the appointment of roles to the subjects and objects

(4) the description of the causal relations between the events (actions)

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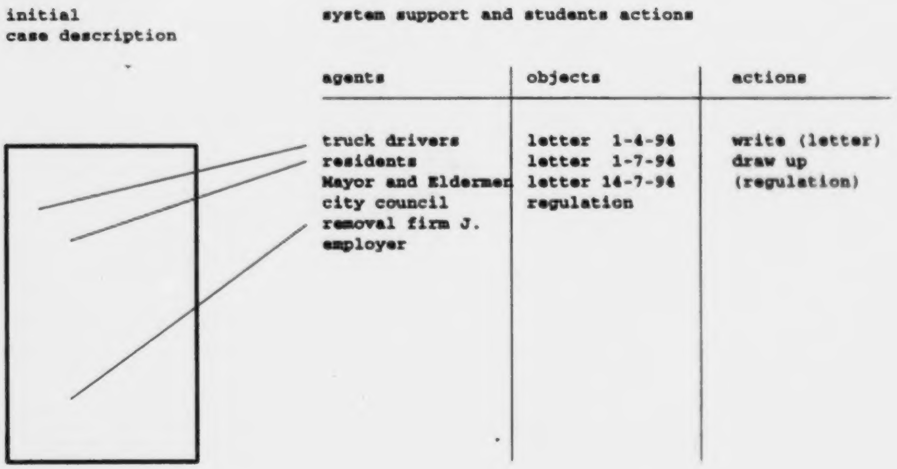
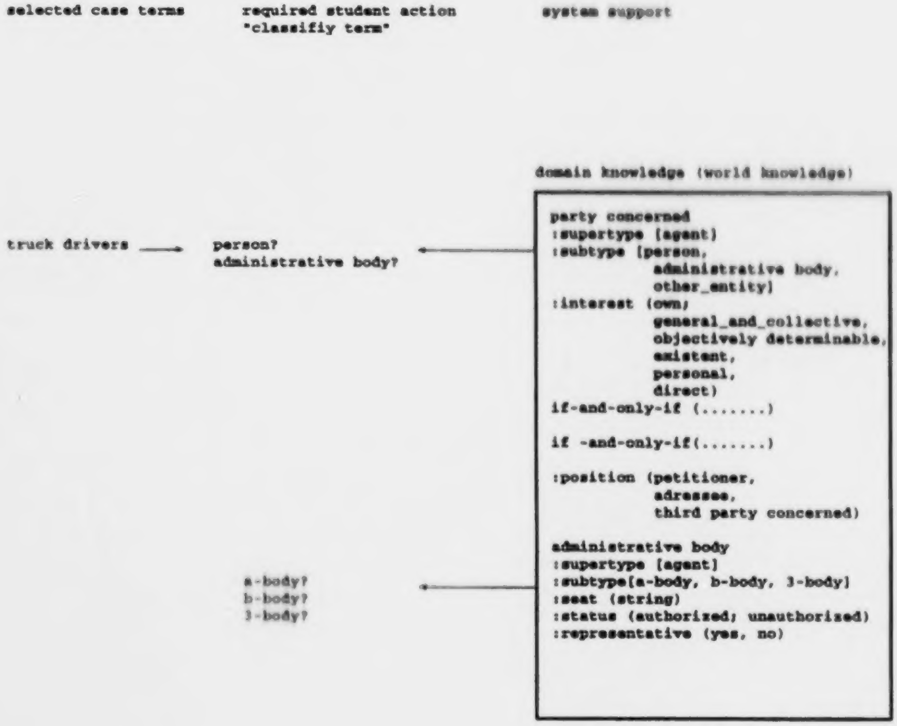

initial
case description
system support and students actions

agents	objects	actions
truck drivers	letter 1-4-94	write (letter)
residents	letter 1-7-94	draw up
Mayor and Eldermen	letter 14-7-94	(regulation)
city council	regulation	
removal firm J.		
employer		

Figure 2: sort case


selected case terms
required student action
"classifiy term"
system support
truck drivers
person?
administrative body?
a-body?
b-body?
3-body?
domain knowledge (world knowledge)

```
party concerned
:supertype [agent]
:subtype [person,
          administrative body,
          other_entity]
:interest (own;
          general_and_collective,
          objectively determinable,
          existent,
          personal,
          direct)
if-and-only-if (.......)

if -and-only-if(.......)

:position (petitioner,
          adressee,
          third party concerned)

administrative body
:supertype [agent]
:subtype[a-body, b-body, 3-body]
:seat (string)
:status (authorized; unauthorized)
:representative (yes, no)
```

Figure 3: classify term

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The next task in the task structure is: translate case terms in the case into legal terms
PROSA requires the actions 5 and 6.
(5) the selection of terms from the case
The system offers the complete and sorted case description. The action required is to take a term from the sorted terms list.

(6) the classification of terms
The system presents the list of terms ready for classification and the domain knowledge model (in this example the model of the knowledge of the administrative procedural world). The student action required is to match a term from the list with a legal term in the domain model [Fig. 3].

Summary

To be able to organize a principled instruction of systematic legal case solving, we combine research in the field of legal case solving and artificial intelligence. The categories of knowledge involved in the task of legal case solving are described as task knowledge, domain knowledge and inference knowledge. In legal case solving it appears that the solution should reflect the case solving process for the purposes of motivation and control. The inference structure is therefor translated into actions presented by the system. PROSA monitors the student when she is engaged in an action and provides coaching. Future research will focus on the following subjects: (1) different ways to present a legal problem situation, (2) a description of the remaining (sub)tasks, and (3) the formulation of decisions on how to interfere in the student's problem solving process and when to interfere.

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Paper Modelling from a Distance: Computational Crafts on the Web

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Abstract: Much of the rhetoric surrounding the World Wide Web celebrates the advantages of the "virtual" (and by implication, immaterial) world. In contrast, we see the Web as potentially enhancing the practice of handicrafts. This paper reports on recent developments in implementing a "Platonic Solids Applet" in Java to permit students to select and decorate folding nets for polyhedral solids made from paper. We describe both the applet and the original paper-sculpture design application, *HyperGami*, to which it is related; we describe ongoing work toward creating a mathematical children's book integrated with Web-based elements; and we discuss the strengths and limitations of the Web in the practice of handicrafts.

I. Introduction

Much of the current rhetoric surrounding the burgeoning popularity of the World Wide Web emphasizes the Web as an emblem of "virtuality." In this vision, the primary advantage of the Web lies in its ability to allow human beings to transcend the limitations of time, space, the body, and the physical world generally. Those interested in art and science may visit virtual galleries and museums; students may attend virtual classrooms; experiments may be performed in virtual science laboratories; social structures are developed and cultivated within virtual communities and "worlds." In every case, the implicit assumption is that the conditions of physical embodiment—in actual laboratories, classrooms, museums, bodies—collectively represent a barrier or expense to be overcome by a more efficient culture of incorporeality.

Eloquent statements on behalf of this vision of technology are not hard to find. In Nicholas Negroponte's book *Being Digital*, he writes, "In the same ways that hypertext removes the limitations of the printed page, the post-information age will remove the limitations of geography. Digital living will include less and less dependence upon being in a specific place at a specific time...." [Negroponte 1995] A similar theme of unlimited possibility and abundance is invoked by Michael Benedikt in his introduction to *Cyberspace*, a collection of essays on virtual worlds: "Cyberspace: Through its myriad, unblinking video eyes, distant places and faces, real and unreal, actual or long gone, can be summoned to presence.... Around every participant, this: a laboratory, an instrumented bridge; taking no space, a home presiding over a world... and a dog under the table." [Benedikt 1991] Sherry Turkle, in her thoughtful (and often cautionary) book *Life on the Screen*, describes a world in which constructs such as friendship, love, and personality undergo a metamorphosis under the influence of computer-based telecommunications: "In the story of constructing identity in the culture of simulation, experiences on the Internet figure prominently, but these experiences can only be understood as part of a larger cultural context. That context is the story of eroding boundaries between the real and the virtual, the animate and the inanimate, the unitary and the multiple self...." [Turkle 1995]

Compelling as these visions are, we do not believe that they need represent a monolithic view of the purpose and meaning of technology generally—or of the World Wide Web in particular. Our own interests lie in the integration of computational media and handicrafts—that is, in the use of computers (and communications) to enrich and rethink traditional creative activities rather than to render them obsolete. In pursuing this line of thought we have developed an educational application named *HyperGami* [Eisenberg & Nishioka 1997], which may be thought of as a design environment for polyhedral paper models and sculptures. Polyhedral modelling is of course a venerable craft activity in mathematics education [Mühlhausen 1993, Pedersen 1988]; but the goal of HyperGami is to move beyond the traditional boundaries of that activity, and to extend its creative potential by permitting students (as well as

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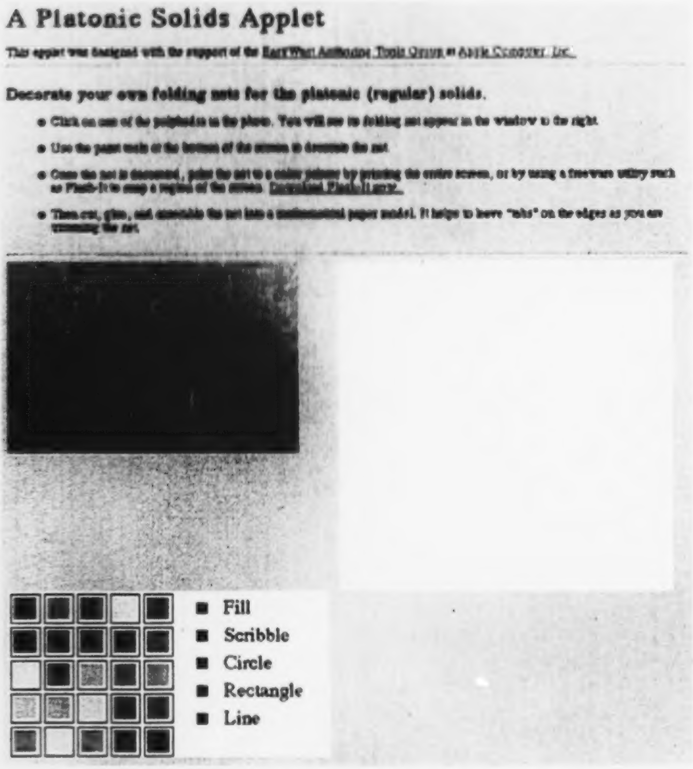
professional mathematicians and designers) to create polyhedral models whose levels of complexity and aesthetic appeal would have been unachievable in the absence of computers.

This paper reports on recent developments in making HyperGami constructions and activities available over the World Wide Web. The Platonic Solids Applet is a newly-developed Java program that allows students to create decorated paper models of (HyperGami-designed) polyhedra. Though still in a relatively early stage of development, the Platonic Solids Applet points the way toward more powerful tools for paper sculpture (and for mathematical craftwork) over the Web.

The following section of the paper will describe the current implementation of the Platonic Solids Applet, and its relationship to the larger HyperGami system from which it is derived. The third section will describe a broader project for which our Platonic Solids Applet represents an initial step: namely, the design of a mathematical children's book to be combined with interactive elements and tools available over the Web. The final (fourth) section will describe ongoing work in the HyperGami project with emphasis on the ways in which computational crafts may (or, importantly, may not) ultimately be enhanced by the capabilities of the Web.

II. The Platonic Solids Applet: an Overview



A Platonic Solids Applet

Decorate your own folding nets for the platonic (regular) solids.

Figure 1: A screen view of the Platonic Solids Applet.

The Platonic Solids Applet is a Java applet[1] that permits users to create decorated paper models of the five regular, or Platonic solids (i.e., those solids consisting entirely of regular polygons as faces, and for which

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[1] The Platonic Solids Applet was written in Java and created using both the Roaster Integrated Development Environment (Natural Intelligence, Inc., Cambridge, MA) and the Sun Java Developer's Kit

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each vertex is included in the same number of faces). The essential idea of the applet is that the user may select a polyhedral object depicted in a photograph; the program then supplies the user with a "folding net" for that object (a two-dimensional pattern that can be folded into the desired solid). This folding net may be decorated by the user, after which it may be output to a local color printer, cut out, and folded into a tangible solid model. It should, perhaps, be mentioned that while still a relatively simple and early version, the Platonic Solids Applet nonetheless required upwards of 1000 lines of Java code to implement (largely due to the still embryonic state of Java environments and libraries).

The screen appearance of the Platonic Solids Applet is shown in [Fig. 1]. At upper left, a photograph of five solid models is shown; when the user selects one of these (via a mouse-click) the folding net for the chosen solid appears in the larger area toward the right of the screen. [Fig. 2] depicts the result of selecting the icosahedron model (composed of twenty equilateral triangles); here the folding net for the icosahedron is displayed. This net may then be decorated by a variety of means supplied by the paint tools region at bottom left. In [Fig. 2], the user has employed these tools to add a circle, rectangle, line, and "scribble" decoration to the net; she has also filled several of the triangles in the net. The paint tools support these sorts of decorations in the standard manner: for instance, to create a circle, the user chooses a color (from the pre-supplied set in the paint tools box), and then chooses the "circle" radio box. She proceeds to press the mouse button down at the point where the desired circle should be centered, and holds the mouse button down, dragging the mouse cursor to the desired radius of the circle before releasing it. [Fig. 2] depicts a similar (and likewise standard) method for drawing a "scribble" in freehand fashion using the mouse.

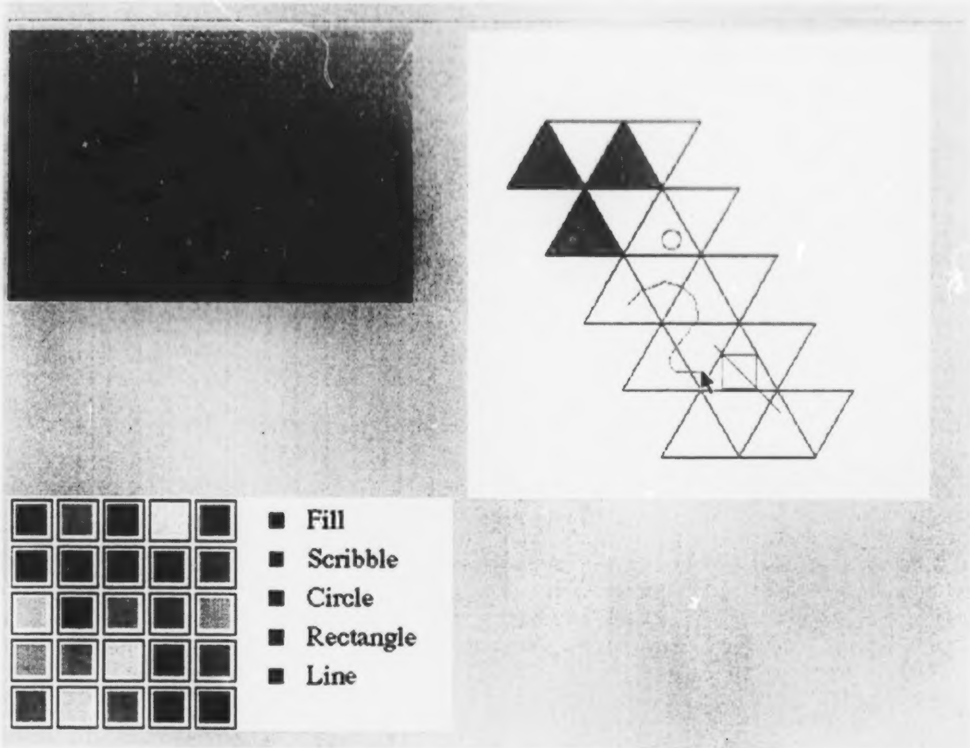

Figure 2: The process of decorating a net for the icosahedron (the shape at upper left in the photograph).

(Sun Microsystems, Inc., Mountain View, CA). The applet may be viewed by following a pointer from the URL:

http://www.cs.colorado.edu/~l3d/systems/hypergami/

Note that the character "l" in "l3d" is a small "L", not a numeral "1".

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In its implementation, the Platonic Solids Applet represents an initial step in combining our existing HyperGami system with Web-accessible tools and activities. While the user of the applet may, for instance, decorate folding nets, she cannot do so in nearly the range of methods available in HyperGami (which include patterns, textures, programmable gradients, and turtle graphics, among many others). Perhaps more importantly, the central activity in HyperGami is the design of new, never-before-seen custom polyhedra; this is achieved by applying a variety of "customization operations" to starting shapes. [Fig. 3] illustrates the idea: here, we have begun with a HyperGami icosahedron; we have "sliced off" the upper portion of that shape; stretched the remaining portion; and finally, added a "prism cap" at the top of the shape. The HyperGami system is then capable of unfolding this shape to yield the folding net depicted in [Fig. 3].

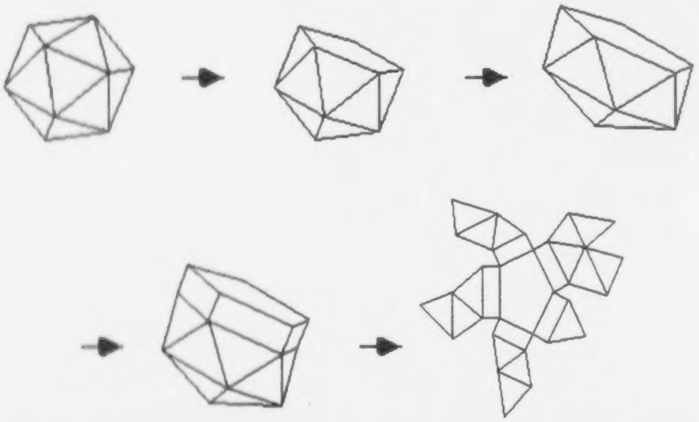

Figure 3: Designing a customized polyhedron in HyperGami. An icosahedron is sliced, stretched, and capped; the "unfolded" pattern is shown in the final stage.

The Platonic Solids Applet is, in its current stage, intended only for the decoration of existing HyperGami solids (our running version includes the five regular solids, but other photographs and solids would of course be feasible additions). The applet cannot be used, however, to design new solids and nets; for this, the full HyperGami system would still be needed.

III. An Interactive Children's Book Blending Mathematics and Art

The Platonic Solids Applet, besides making HyperGami polyhedra available over the Web, is also part of a broader and more ambitious project in mathematics education—one including both traditional and distance learning media. We have recently completed a set of polyhedral constructions for a mathematical children's book entitled "AlphaBetaHedra"—an alphabet book of paper sculpture. In this book, each letter of the alphabet is represented by a photograph of a paper sculpture based on classical polyhedra. Two examples are shown in [Fig. 4]: the letter "F" (for "finger puppethedra") and the letter "G" (for "greenhousehedron"). Elements of these sculptures include the dodecahedron (the head of the pirate finger puppet), the cuboctahedron (on which the body of the soldier finger puppet is based), and the small stellated dodecahedron (the "flower" shapes in the greenhouse).

Our goal in developing "AlphaBetaHedra" is to combine the book with activities (or perhaps partial constructions) that are available over the Web. Readers of the book might be supplied with folding nets for some of the constructions in the book; other constructions could be made available through means such as those suggested by the Platonic Solids Applet. In this fashion, the Web would not be used as a primary means of presenting educational material, but rather as a means of enriching the potential of traditional media. It should also be mentioned that "AlphaBetaHedra" is only the first of what we hope will be a series of books designed in the same spirit—i.e., books that refrain from "preaching" mathematics and instead integrate the subject into a more natural and uncontrived framework in children's literature. We are currently at work on a book that moves beyond "AlphaBetaHedra" to include a narrative, fantasy-like story line.

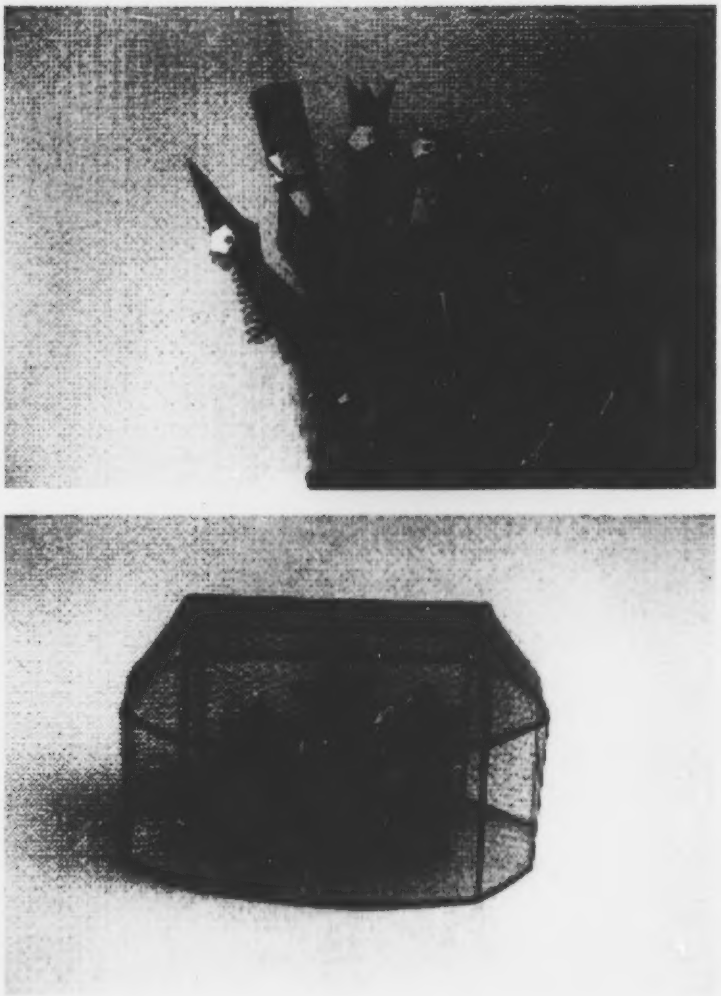

Figure 4: "F for finger puppethedra" and "G for greenhousehedron" from *AlphaBetaHedra*.

IV. Further Directions in Using the Web to Support Computational Crafts

There are certain obvious advantages to using the World Wide Web to support tools like the Platonic Solids Applet—and, more generally, to support the integration of computational media and handicrafts. Extended communities of students (and professional craftspeople) may share insights, experience, and advice; even more interesting, they may share specifications for constructions in various stages of completion. We can envision, for instance, the creation of HyperGami paper sculpture exhibits—real-world exhibits, existing in actual studios—that may be visited both in "real life", and over the Web, and that may be extended by their visitors. (People might, for example, send in folding nets for new constructions which could then be printed out and constructed by member of the exhibit staff "on-site.") In this fashion, a physical space of crafted objects may be enjoyed, studied, and contributed to by a widespread group of enthusiasts.

Despite these optimistic scenarios, however, we feel it important to note that there is an inevitable—perhaps productive—tension between the "virtual" aesthetic of the World Wide Web and the homey, earthbound pleasures of working by hand, with traditional materials. Our own feeling is that systems such as HyperGami and its eventual Web-based cousins—indeed, technological systems generally—should be

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judged according to how well they enrich the totality of lived experience, both physical and virtual. As Allucquere Rosanne Stone writes, "[I]t is important to remember that virtual community originates in, and must return to, the physical.... Even in the age of the technosocial subject, life is lived through bodies." [Stone 1991] For our part, in a world increasingly defined by the apparent freedom of the disembodied community, we sense a certain longing for the restraints embodied by the behavior of paper, wood, clay, glass, metal, and wax. We hope that innovations such as the World Wide Web may eventually help to intensify the human relationship with materials, and thus to soothe the tensions that they have played such a large part in creating.

Acknowledgments

We are indebted to the ideas and encouragement of Hal Abelson, Michael Mills, and Jim Spohrer, among many others. Thanks to Gerhard Fischer and the members of the Center for Lifelong Learning and Design at the University of Colorado for providing an intellectual home for our efforts. This work has been supported in part by the National Science Foundation and the Advanced Research Projects Agency under Cooperative Agreement CDA-9408607, and by NSF grant REC-961396. The first author is supported by a fellowship from the National Physical Science Consortium; the second author by a Young Investigator award IRI-9258684. Finally, we would like to thank Apple Computer, Inc. for donating the machines with which our research was conducted.

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Man-Machine Communication using Eye Movement

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Abstract

Eye Mark Recorder has been introduced to analyze the behavior of a learner seeing subject matter on the CRT. And several preliminary experiments are made to understand the visual cognition-motion process of human being. The rule-based simulator for visual cognition-motion of human being is developed to explain the experimental data consistently.

1.Introduction

Several media on the computer have been used widely in education.The so-called multimedia on the computer gives us a new educational environment. Many subject matters on the multimedia environment are being developed all over the world. We can use various subject matters on the computer in a classroom now.

But , we feel it difficult to evaluate multimedia subject matters compared to the subject matter developed on the traditional computer. There are several aspects concerned with visual cognition of multimedia contents.

It is important to analyze the visual cognition behavior of a learner seeing the multimedia subject matters on the computer to make variation standard for multimedia subject matters. So, we have introduced Eye Mark Recorder to analyze the visual cognition behavior of the learner seeing subject matters.1)

Education has not been regarded as science but merely as empirical skill so far.

We want to change education from skills to science. We want to realize that by researching the visual cognition behavior of a learner.

In this paper, we report the result of basic experiment in which a learner communicating with computer visually. And we try to construct the parallel production system which can explain and simulate the observed visual cognition behavior of human being based on schema theory.

2.The used Eye Mark Recorder

The used Eye Mark Recorder (hereafter we call it EMR.),NAC EMR-600 is shown in Figure 1. The eye mark of the testee is usually analyzed by a human researcher in ex post facto way . The movement of eye mark longer than 1 second can be analyzed in this approach , but the movement of eye mark in the short time range from 10 msec to 100 msec cannot be detected by a human researcher. So , it is necessary to develop a measuring system to detect eye mark data in this short time range.

We have developed the calibration system for EMR which can detect 600 eye mark data per sec to analyze the visual cognition behavior of a human being.(Figure 2)

Using the real time data obtained from the calibration system , the computer can vary what is shown on the CRT quickly. As a result , some environment which can respond quickly with eye movement of human being has been developed.

Figure 1. The used Eye Mark Recorder ,Nac EMR-600

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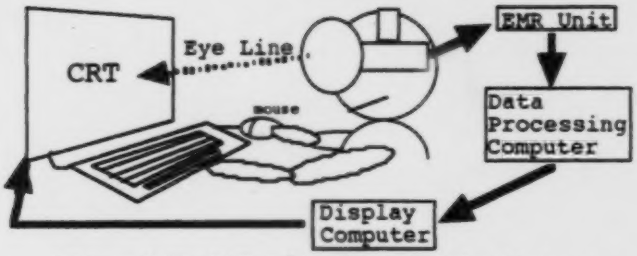


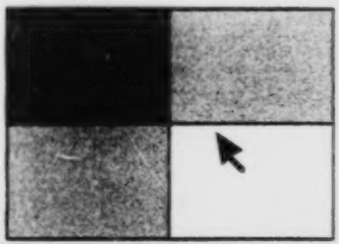
Figure 2. Real Time Eye Mark Tracing System

3.Flipper Game

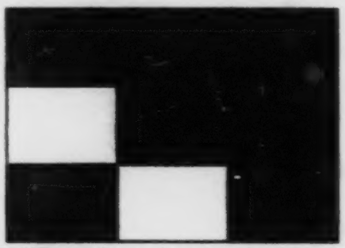
There is a computer game called Flipper(Figure 3).A player of this game moves mouse to select the squares divided on the screen, and then he can vary the color of a selected square by clicking mouse. Six colors are used in this game.

The color of selected square changes in the cyclic sequence. For example ,purple , red ,green , blue and so on. On the other hand , the color of each square varies randomly at regular intervals in time on the CRT .When the colors of all the squares coincident , then the game is cleared. So , a player of this game must vary the color of squares as fast as possible.

The player can confirm which square is selected by seeing a mouse pointer controlled by himself in this original Flipper game.



a) Original Flipper Game the arrow designates mouse pointer



b)The Modified Flipper Game plus(+) designates eye mark pointer

Figure 3. Flipper Game

We modified the original Flipper game into one which selects and changes the color of selected square using eye movement. We have developed four types of modified Flipper games below (Table 1).

		selection	select way	pointer
type1	●	Eye	Mouse buttom	Eye Mark
type2	■	Eye	Mouse buttom	Nothing
type3	○	Eye	Gaze	Eye Mark
type4	□	Eye	Gaze	Nothing
type5	×	Mouse	Mouse buttom	Mouse pointer

Table 1. types of Modified Various Flipper Games

type1
A player can select a square by staring at it . And he confirms his selection by seeing his eye mark pointer on the CRT. And he can change the color of the selected square by clicking the mouse.

type2
In this type of modified Flipper game , the eye mark pointer is not indicated on the CRT. So , the player must change the color of square using mouse without the help of eye mark. We expect high switching efficiency in this case , but the learner doubts if this square is really selected or not ? So, he hesitate to click mouse in some case.

type3
In this modified version of Flipper game , the player need not click the mouse to change the color of the square but he has only to gaze at the square .If the eye mark stays in a square for 0.6 sec , the system automatically changes the color of this square in predefined cyclic order. In this case , the eye mark pointer is generated on the CRT , so the learner can select a square with help of eye mark pointer.

type4
In this type of Flipper game , the eye mark pointer does not appear on the CRT. So the learner must select a square without the help of eye mark pointer. The highest switching efficiency is expected ,but the learner is puzzled which square is selected by his own eyes in this modified type of Flipper game.

summary of modified Flipper games
The observation of the behavior of the learner playing modified Flipper games from type 1 to type 4 is summarized in Figure 4.

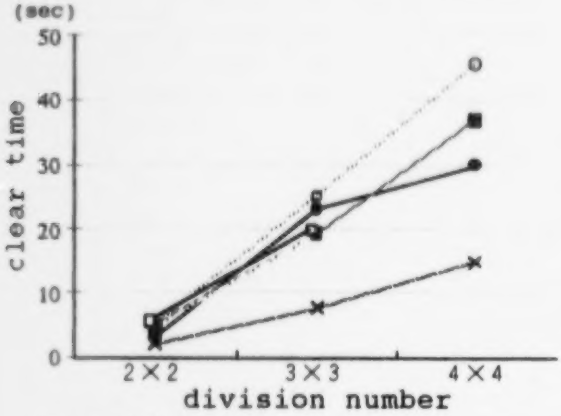


Figure 4.Used time to clear Flipper games

The number of divided squares is plotted in horizontal axis , and the time used to clear a game in each division is plotted respectively in vertical axis.
Type 3(Type 4) is the most difficult for a player.
Type 5 is the easiest. It is the original Flipper game using mouse.
Type 1 is almost the same as type 5 in 5*5(five times five) division in our preliminary observation , but there is statistical fluctuation in our data.

To explain these results in detail , we should construct the model which can explain the cognition-motion process in human brain. This will be discussed in chap.7 in detail.
We are aware that eye movement can be applied to the man-machine interface which requires quick response. But, there is a serious problem. It is not so comfortable for a learner to use his eye movement continuously. Our learner were often tired from using eye movement to select a square in these modified Flipper games.
We need to think of how to avoid this defect in man-machine interface using eye movement.

4. Determination of focus point

When a user fix his eye on the point P on the CRT , detected user's eye mark fluctuates around point P shown in Figure 5. $^{2)}$The neighboring eye marks are grouped into focus region of point P when mutual distance of constituent is smaller than focus size. Focus point of P is defined as the mean of the coordinates of points belonging to focus region.

In the actual case , this focus point of P does not always coincident with point P. The system may use this focus point to guess what is seen by the user.

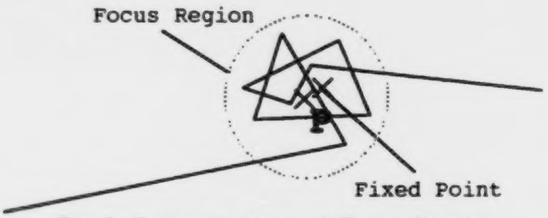


Fig.5. Determination of Focus Region

The user fix his eye on the some regions on the CRT such as pull down menu in Figure 6 to communicate with computer.When focus point is included in this region , the system guesses this region is seen by the user. When a user reads a sentence shown on the CRT , focus points corresponding to each character are obtained.3),4)

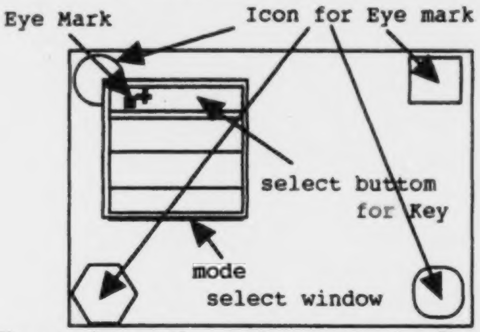


Figure 6. The new interactive environment using Eye Movement

The points corresponding to the movement from a character to another and to blinking are not grouped into focus region.

The number of focus point may vary depending on the value of focus size. The dependence of the number of focus point to focus size is shown in Figure 7.

We decide 1.6 degree as optimum value of focus size from these data.

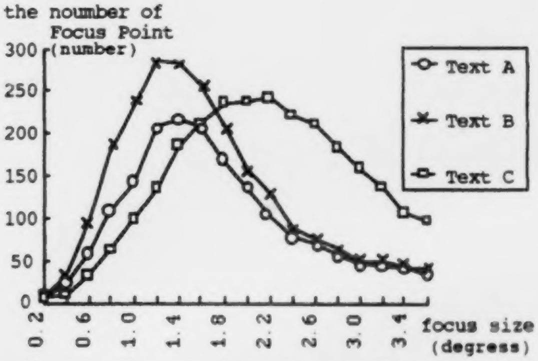


Figure 7. Dependence of the number of Focus Point on focus size

5. Man-Machine interaction using eye movement

The triangle in Figure 8 is an eye mark pointer of the user watching the hypertext on the CRT. This is not the real time eye mark but focus point defined chap.4.

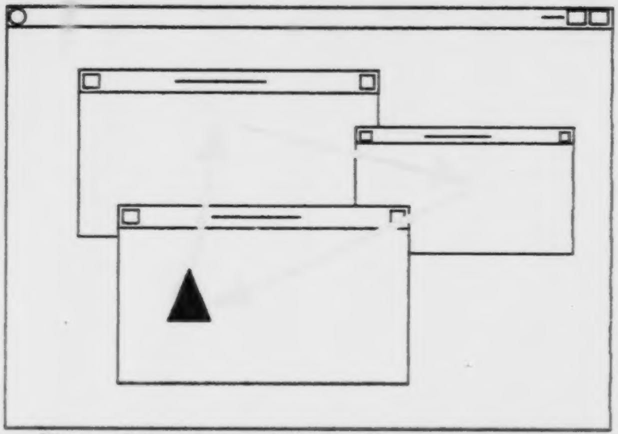


Figure 8.Swiching of Active Window using eyes

When the user moves his eye from the front window to the buck window, the focus point moves from the front window to the back window, then the system automatically changes the back window to the active window. We made our user select an pull down menu on the CRT using eye movement . The menu which has height about 3 degree can be selected safely using eye movement. But this manipulation to select pull down menu using eye motion is not comfortable for some users. But changing of windows using eye movement is comfortable manipulation for all users.

We have developed another mechanism to help a user to select window and menu not using the coordinates of eye mark but using velocity of eye mark.

When a user moves his eyes from a window to another , the velocity of eye mark can be detected by the system. So the system can guess this user want to change the window using the information of velocity of eye mark without detecting the final position of eye mark. The quick manipulation may be expected using velocity of eye mark instead of the coordinate of it.

In Figure 6 , there are four icons on the corner of CRT. If a user wants to select an icon , then he moves his eyes in the direction of the icon from the present point pressing reserved key for this type of selection.

6. The analysis of the process of typing text

A learner types text on the paper using keyboard and he compare characters typed on the CRT with a text on the paper(Figure 9). If a learner is a beginner, his eye moves on the keyboard to see whether his finger is on the exact key or not. If he makes a mistakes in typing character , he must delete wrong character and retype exact character. His eye moves from text on the paper to the typed text on CRT , and conversely from CRT to text on the paper.Typing is very complicated process from this point of view.In this research , we made our learner type random text to avoid chunking of characters.

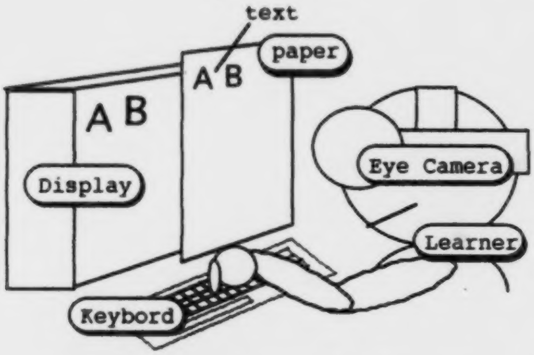


Figure 9.Typing Text using Keybord

To explain and understand this complicated manipulation process, some model for cognition-motion process in his brain is necessary. At first , we used simple serial information processing model for human cognition-motion process to analyze this typing manipulation process(Figure 10).

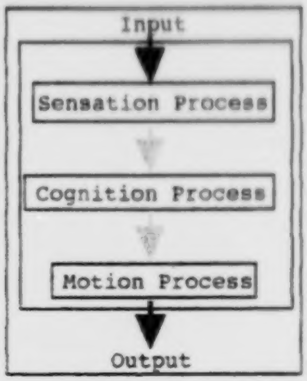


Figure 10 Simple Serial Information Processing Model for cognition-motion Process

At first , we obtain time parameters of individual learner for cognition-motion process using typing data obtained from keyboard scanning. And we try to estimate the time used to type another random characters using the observed parameters.

Of course, several parameters concerned with eye movement cannot be obtained directly, so the capability to estimate the time used for typing is rather small.

The actual used time differs seriously from predicted used time from the Card model using only keyboard scanning data (Table 2).

Testee	Size of Working Memory	Time used for Serch&Memorize	Time used for Typing	Time used for Search&Compare	Rate for Type Miss	Rate for Memorize Miss	Actual Used Time	Predicted Used Time
	Capacity μWM	$R+\mu wmM$ (msec)	T (msec)	$R+\mu wmC$ (msec)	(%)	(%)	(Sec)	(Sec)
A	1	370	410	230	0	0	49.61	92.77
B	2	550	680	710	0	0	76.78	125.15
C	1	140	790	310	0	0	56.03	101.69
D	2	340	410	1090	4	0	67.78	151.19
E	2	650	280	330	0	0	41.28	70.45

Table 2.Cognitive parameters for individual learner

It is necessary to know several parameters concerned with eye movement to improve model. So , we made our learner put Eye Mark Recorder on and type the text.

We can get parameters concerned with eye movement directly in this case, so we can construct more realistic model for typing. As a result , the capability of prediction for used time is remarkably improved.(Figure 11)

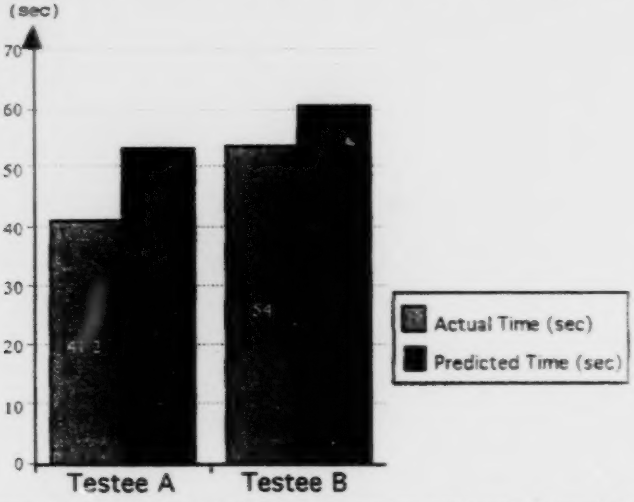


Figure 11. Predicter Used Time compare with actual used time

As is well known , this cognition-motion process may be parallel ,so some parallel model of cognition-motion process is necessary to obtain more realistic model of typing process. This is discussed in detail in chap.7.

7. Recognition-Manipulation Simulator SIMPASI

In the above, we report several results of measuring eye movement of a learner interacting with a computer. These processes are very complicated and depend on the situation in which a learner is confined. As the behavior of eye mark depends on the situation, ordinary data analysis is not so effective.The approach based on reduction is not effective in this domain. The approach to extract the feature directly from the measured data is not effective.

Some models are necessary to extract feature of eye movement from the data.

As is well known , there are several hierarchies of information processing in the human brain concerning visual recognition. The schema theory may be promising as a model of hierarchical visual cognition-motion system.[5)]

So, we have developed rule-based modeling of visual 'recognition . This model is quite general , so it may have capability to explain different cognition processes reported in this paper because many local rule corresponding various experimental situation can be assembled.

We have developed parallel production system called SYMPASI(SYMbolic PArallel SImulator). It is possible to set retardation time for each rule to fire in SIMPASI. So , recognition simulation is generated as a result of successive adaptation of rules. We can tune the system by assembling and modifying various production rules in SIMPASI.

Individual phenomenological facts concerning visual recognition reported in this paper can be assembled in SIMPASI , then overall cognition-motion phenomena is generated by the successive adaptation of rules in working memory of parallel production system. The structure of the rule-based simulator SIMPASI is shown in Figure 12.The part of rules of SIMPASI tuned for modified Flipper game which is reported in chap.4 in detail are shown in appendix .

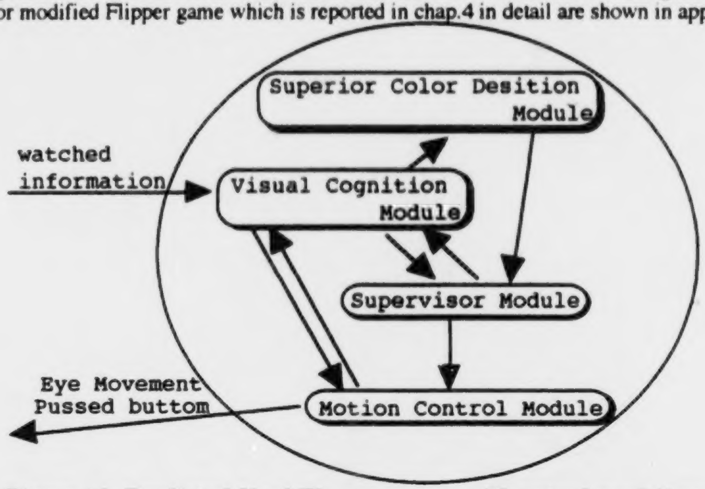


Figure 12. Predicted Used Time compare with actual used time

8. Conclusion

We report several preliminary observations of visual recognition of a learner interacting with a computer. EMR cannot distinguish two points in the angle less than 2 degree. So there is severe restriction of experimental situation.

Vast experimental data is generated in our experiment . The straightforward overall explanation of visual cognition of a learner is difficult if we use ordinary analysis of measured data. So we have developed rule-based simulator of these visual cognition process of a learner. It is very promising to analyze the data using this type of simulator.We have next plan to estimate the level of a learner learning computer language using EMR.[6)]

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Appendix Example of rule of SIMPASI

We set two levels to explain and understand human behavior. Supervisor level is located on schema level. Several example of rules and schema are shown in the following.

Supervisor level

```
IF superior color and target color is different
  THEN change target color
IF interruption is frequently
  THEN make target color to next color of superior color
IF order of screen is corrupted
  THEN make screen order
IF interruption is too frequent
  THEN give up
IF too click the segment over the target color
  THEN more repeat clicking.
```

Schema level

```
Get superior color schema
   Eye move schema
Get screen order schema
   Eye move schema
Get target segmentation schema
   Move cursor schema
 Chase cursor schema
    See Target schema
       Eye move schema
Repeat Clicking schema
   Clicking schema
```

Implementing Collaborative Learning Through Mainstreaming Faculty Use of Technology

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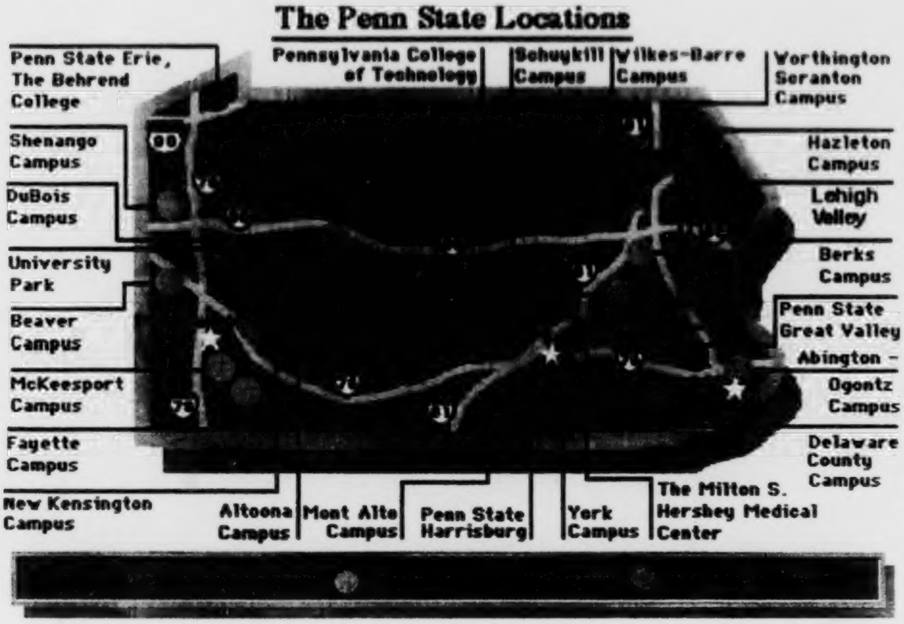
Abstract: The Commonwealth Educational System of the Pennsylvania State University seeks to make learner-centered instruction the norm in all its undergraduate programs. Project Empower has been conceived to quickly bring as many CES faculty as possible into the learner-centered paradigm. Further, the project seeks to equip faculty and campuses with the human and technological resources required to support a contemporary, active and collaborative learning environment.

The Problem:
Evidence shows that students learn more by actively participating in their learning environment. "We learn by doing" is a concept that has been recognized for decades; but why, until only recently, have we submitted our students to the routine of sitting in stationary seats in lecture halls passively taking notes? How do we implement the paradigm shift from passive learning to an active collaborative learning environment? The Penn State University Commonwealth Educational System is working toward a realization of this paradigm shift by empowering its faculty.

Background:
The Penn State Commonwealth Educational System (CES) is a network of 18 campuses across Pennsylvania with an emphasis on teaching and small class size.


The Penn State Locations
Penn State Erie, The Behrend College
Pennsylvania College of Technology
Schuylkill Campus
Wilkes-Barre Campus
Worthington Scranton Campus
Shenango Campus
Hazleton Campus
DuBois Campus
Lehigh Valley
University Park
Berks Campus
Beaver Campus
Penn State Great Valley
Abington - Ogontz Campus
McKeesport Campus
Fayette Campus
Delaware County Campus
New Kensington Campus
Altoona Campus
Mont Alto Campus
Penn State Harrisburg
York Campus
The Milton S. Hershey Medical Center
90
79

The assessment conducted for the 1994 CES Plan for the Future, as well as the individual campus assessments demonstrated a need for a focused unit to support instructional change. The assessment concluded that if the CES is to adequately prepare students for current and future careers, it should offer a curriculum that emphasizes active and collaborative learning. This type of learning activity fosters the group work skills required in today's workplace. In addition, the curriculum should develop lifelong learners,

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since today's college graduates are likely to change both job and career several times during their lives, and need to continually learn new information and skills. Given the globalization of business and communication, students should learn to use electronic communications technologies for research, collaboration, and publication.

Key points that were evident:

- The piecemeal changes brought about solely through the isolated efforts of individual instructors did not create sufficient impetus or support for systemwide change to the type of contemporary learning environment described above.
- A substantial population of "nontraditional" students, more mature and often unable to attend on-campus classes, is both available and eager to access CES programs through distance education technologies.
- The use of communications technologies can enable the CES to make the expertise of its faculty available across the state. CES campuses should be able to offer high-demand programs on a reduced overhead basis via the sound pedagogical use of instructional technologies.

The Center for Learning and Academic Technologies (CLAT), a centrally located unit, was founded in 1995 to support these needs. Three key issues emerged that CLAT would need to address:

Leverage: How can a small, central unit effectively and efficiently produce progress with 850 geographically dispersed faculty and meet the shared needs of 18 campuses across Pennsylvania?

Access: How can CES ensure that faculty, students, and staff have adequate access to the technologies required to develop and to implement a contemporary learning environment both on campus and from remote locations?

Quality and Cost Effectiveness: What quality-control functions can C-LAT both provide and disseminate to ensure that the CES investment in the use of various technologies actually contributes to achieving a learner-centered, active and collaborative college experience for our students? How can we quickly and thoroughly reshape both pedagogical vision and teaching practices? We want to avoid the trap of simply putting old pedagogy out via a new publishing mechanism. Our aim is to radically improve the learning experience of our students.

Rationale:

- The products of instructional innovation must demonstrate and support learner-centered instruction and must be made available to faculty and students throughout the CES.
- Effective learner-centered instruction that can be distributed throughout a statewide system requires excellence in both instructional design and multimedia delivery.
- Faculty must feel ownership of the innovations, and should come to see themselves, both individually and as a group, as effective innovators.
- To be viable, any plan to effect significant, lasting change in a large distributed system must be cost-effective from its inception. This requires powerful leveraging of limited resources. It also increases the likelihood that a program successful at Penn State can succeed elsewhere as well.

Project Empower:

Project Empower, was designed to meet these needs. Faculty were "empowered" with the computer, telecommunications technology, and instructional design support that would encourage a shift from teaching by traditional and passive lectures to an active and more collaborative process that incorporated both lecture and discussion hand in hand in the learning process. Faculty with a desire to switch from an emphasis on teaching to an emphasis on learning could apply for funding for equipment, release time and expert support that would make this shift possible.

Faculty were encouraged to submit proposals. In a simple 2-3 page proposal, faculty had to address a specific instructional problem and suggest how they could use a collaborative solution to solve the problem using a non-traditional approach. Faculty were encouraged to start small with a project that would encompass a few class periods and no more than twenty percent of the class. The project should make a demonstrable contribution to creating a student-centered curriculum.

Learning characterized by project-oriented active student participation and collaboration requires a paradigm shift. The faculty had to be willing to change their classroom role from that of primary "information giver" to that of "facilitator". This in turn, would change the role of the student from passive "listener/note-taker" to "active-learner".

The faculty were provided a one-course release during the Spring 1996 semester, their choice of a Mac or IBM notebook computer, and design support provided by a local Instructional Development Specialist. Each campus was also supplied with a media development workstation and appropriate software.

The response from the faculty was overwhelming with 108 faculty funded for Empower I. Many of these projects were collaborative efforts between faculty using a cross-disciplinary approach or across two or more campus locations. Project Empower has created an arena where both non-computer users and high-end developers can blossom and flourish. Faculty from all disciplines have created new learning environments for their students.

Faculty became the learners also. The various needs of the projects required that new skills be learned - e-mail, conferencing, collaborative learning, group dynamics, presentation, authoring, instructional design, and Web design. Assessment of learning outcomes was an important consideration as well. Faculty put the finishing touches on the project in the Summer 1996 and were required to implement the project in the course for the following Fall semester.

Faculty also report significant changes in instructional strategies as a result of participation in these programs. A survey conducted at the end of the Fall semester 1996 of Empower faculty found:

Teaching Methods	**Pre-Empower**	**During Empower**	**Post-Empower**	**% Pre-Post Change**
Extended lecture	42	31	34	-19%
Small group discussion	24	32	35	46%
Collaborative group work	26	42	42	62%
Asynchronous learning	8	25	24	200%
Computer lab activities	28	42	43	54%
Electronic conferencing	5	3	18	260%
Thematic linkages across disciplines	8	12	13	63%
Team teaching with other faculty	10	9	18	80%
Coach individuals or teams	7	14	20	86%

Table 1: Empower Changes In Teaching Methods

None of the respondents indicated they would go back to teaching as they had before Empower. Ninety-four percent said they intend to develop additional new learning activities for their students. Seventy-five percent indicated a desire to learn more new teaching techniques. Large numbers also indicated they would revise their units and try them again, and seek more opportunities to collaborate with their peers.

Thus the paradigm shift is taking place. Faculty, after completing the Fall projects, immediately began to plan learner-centered activities for Spring semester courses. For example, students in a Physiology course are working in groups to prepare questions from each chapter before the next weeks class meeting. The group leader must submit the questions to the instructor via e-mail the night before the class meeting. The instructor will develop the class discussion based on the questions. The students are responsible for the

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remainder of the material outside of class. Students are also required to use ADAM interactive CD-ROM's to supplement chapter material. The quizzes for the course will be from material primarily on the CDs.

Faculty have also had to redesign their teaching styles. In another course offered in Computer Science this spring semester a faculty member has implemented problem-based learning. Students are working in teams to reach a programming solution to a real life problem presented by the instructor. Both of these examples represent ongoing changes which were not part of the original Project Empower implementation. These anecdotal examples are perhaps the best representation of the momentum of Project Empower.

One of the key components for a campus to participate in Project Empower was the need to hire and support an Instructional Designer. Consultations with faculty centered around collaborative teaching skills, software skills, learning styles, assessment and evaluation. The concerns of the faculty focused on moving from a lecturer to facilitator, determining the needs of the student audience, communicating to the students what was expected of them, and being able to trust that the students could learn material in an arena other than lecture.

These concerns had to be addressed one by one. The faculty must see the value in audience assessment and learning the teaching skills required in a collaborative learning environment. Pre-tests on group dynamics and computer skills were given to the students. Problem solving exercises were necessary for the students to become comfortable with the projects. It is very important for the students to understand what is expected of them. The faculty must be clear and concise with their material and instructions.

Practically speaking students were required to have e-mail accounts, to become skilled in giving effective presentations, and basic computer use. The faculty had to be cognizant of these needs and had to allocate class and office hour time to the students for learning these tools. The computer labs had to provide the hard ware and software needed to support the projects, as well.

Examples of Empower I projects:

- The Dante Project - MIS faculty and Comp Lit faculty collaborate on a cross disciplinary project where students from MIS are the designers and students from Comp Lit are the content group. Working together these groups produce a multimedia program of Dante's interpretation of sin as it refers to modern day examples.
- Independent Research Project (IRP) - Students are working in pairs on a Genetics research project and pooling data across teams. The final product of the lab will be a scientific paper which each student will produce individually. All instructions about the project and research are delivered through the Web. Shockwave modules and testing on Mendelian and Non-Mendelian genetics are included.
- Engineering problems - Three Engineering Mechanics faculty from three different campuses collaborate on the design of specific real-world problems that will support the content in each chapter of the text. This will be an interactive multimedia program that will utilize calculations and simulations. Students working with the software individually and in groups will obtain immediate feedback on their work.
- English Research - Students use First Class conferencing software to collaborate on development of a diversity related bibliography of Internet research sites.

Student Performance Indicator	**Percentage of Faculty Reporting**
Learned unit content better than before	62%
More interested in content than before	67%
Motivated by group work	54%
Spent more time on unit than before	46%
Picked up technology skills quickly	62%

Table 2: Indicators of Improved Student Learning in Empower Units

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Instructors' reports of student performance were similarly encouraging. The data in Table Two suggest that increased motivation and time on task were achieved and, as predicted in the literature, did indeed contribute to improved learning.

In addition, faculty reported that students gained additional skills that, at Penn State, we consider essential outcomes of a college education. These included:

- Critical thinking
- Problem solving
- Oral communications
- Group processes, teamwork

As displayed in Table Three, the increased use of the computer lab for asynchronous work, including collaborative group projects highlights the limitations of lab-based student computing.

Said lab congestion limits amount of computer-based work assigned	39 or 75%
Said labs lack the quality of computer resources needed to create more Empower units	45 or 87%

Table 3: Computer Lab Limitations

Among the technical limitations most often cited were the need for updated computers, better Internet access, and longer lab hours. In a related project, faculty reported that average students learned Internet skills twice as fast as honors students in a different section of the same course. The most likely difference was that these students had their own laptop computers, while the honors students not involved with the project could only learn when they could get a seat in the lab.

Our plan, therefore, is to increase the number of students bringing up-to-date laptops to campus, and thus at least limit the growth of demand for lab time and equipment. We are rapidly approaching the end of computer lab-building at the Commonwealth campuses. With machines constantly needing replacement, the labs are not economically viable. And no matter how many lab seats we add, we are unable to even keep up with increasing demand.

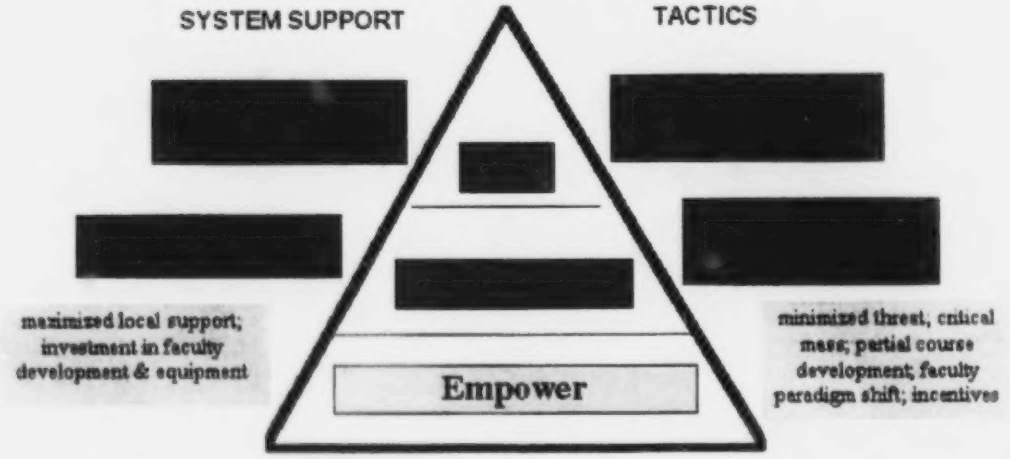
Beyond Project Empower

Project Empower is the first step in the three level pyramidal arrangement of projects that describes our system for generating and supporting instructional improvement and related technology use. As shown in the last illustration, each level uses a particular set of tactics and system support to achieve its outcomes.

At the next level up, Project Vision now builds on empowered courses with faculty interested in engaging in full-course development and delivery. At this level students are also "empowered" with the needed technology.

Vision work results in courses that are almost ready for export around the system, via Core projects. Core projects engage C-LAT staff directly with faculty in creation of integrated multimedia-live-and print course packages that can be used by faculty throughout the system. These courses enable us to reach more distant or location-bound students. Students from around the Commonwealth are able to interact electronically with the instructor and other students.

STRATEGIC PLAN


SYSTEM SUPPORT
TACTICS
maximized local support; investment in faculty development & equipment
Empower
minimized threat, critical mass; partial course development; faculty paradigm shift; incentives

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Full Motion Video and Dynamic Query in a Networked Learning Community

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Abstract

The Baltimore Learning Community, funded as a U.S. Department of Education Technology Challenge Grant, is creating a learning community through use of high quality digital science and social studies resources and high-speed networking. The project is a consortium of public and private organizations including The University of Maryland, The Baltimore City Public Schools, Discovery Communications Inc., Apple Computers, U. S. The National Archives, and the Space Telescope Institute. When implemented, science and social studies teachers will have access to images, text, WWW sites, and full motion video via high speed connections to the Internet. The project employs a client-server configuration with client machines installed in middle school classrooms and downloadable digital resources available from a server. Video streaming also will be supported, with all resources available "on demand" from the server or the World Wide Web. A customized dynamic query interface supports teacher access to the resources.

Technology and Modern Views of Learning

Recent research conducted in a variety of domains, has lead to a rethinking of teaching and learning in content classes. As the characteristics of the 21st century work place, with its reliance on telecommunications and information technologies have become more well defined, it has become clear that students must demonstrate competency in core subject area courses that involve complex thinking and problem solving has. For example, curriculum reform initiatives are under way in Great Britain [Barnett, 1992], Australia [Nicholoson, 1993], Spain [Tarrago, Santallusia, & Marti, 1993], and The Netherlands [van Weer, 1992] where informatics is viewed as a core subject area. Learning in content area classes increasingly is being viewed as process of enculturation, where students enter into "cognitive apprenticeships" with teachers who model the thinking skills associated with a domain [Brown, Collins, & Durgid, 1989]. In the last decade, most national and international standard-setting organization have issued rigorous new content standards that reflect the expectation that students demonstrate proficiency in complex and critical thinking, problem-solving, manipulation of information, communication, and cooperative work. In turn, these new standards have influenced state and national content standards and curricular frameworks that often are intended to serve as benchmarks against which to measure the performance of schools.

Networked Technologies and School Reform

At the same time as notions of learning have evolved, a theoretical basis for learning through information technology has emerged and it is becoming clear that media and method are integrally related [Kozma, 1991]. Video technologies such as videotape and Level 4 videodisks, have become essential tools for teachers in mediating situated learning. However, even though teacher interest in use of video technology has grown drastically in recent years, the VCR remains the dominant form of video technology available for use in classrooms. Videodisk systems are readily available to only about 12% of teachers and regularly used by as few as 5% [NEA, 1991], with most videodisk systems located in high schools rather than middle or elementary schools [OTA, 1995]. There are growing expectations that adoption of networked digital video technologies in schools provides the practical basis for many video solutions. In all likelihood, networked technologies will usurp other classroom technologies as competition for limited school budget dollars intensifies. The clear expectation is that information technology that facilitates distance learning will have a major impact on the organization of schools and the nature of teaching and learning in classrooms for the foreseeable future. Unfortunately, the precise relationship between information technology and school improvement has yet to be described. Even though vigorous school reform efforts are widespread, policy and practice generally have entailed a much greater investment in revamping curricular guidelines and establishing high performance standards than in improving access to information technology [Means, 1994; OTA, 1995]. The project we will describe in the remainder of this paper employs state-of-the-art networked telecommunications technology in a format designed to promote improved instruction in content classes, linked to rigorous performance standards and curriculum guidelines.

The Baltimore Learning Community

The Baltimore Learning Community (BLC) is a collaborative project of the University of Maryland at College Park (UMCP), Johns Hopkins University (JHU), and the Baltimore City Public Schools, funded as one of the U.S. Department of Education Technology Challenge Grant. The goal of this five-year project is to create a learning community through use of high quality digital science and social studies resources and high-speed networking. The project has two major components that both target technology "have not" schools that serve high numbers of students who are academically at risk. One component of the project, lead by a team of researchers from JHU, employs interactive video conferencing and focuses on development of school-community links to facilitate effective school to work transitions. The other component of the project is lead by a team of researchers from the University of Maryland at College Park and focuses on development of effective solutions for integrating high quality digital video and other resources into middle school science and social studies classrooms and linking instruction that uses these resources to rigorous curriculum guidelines measured by a statewide performance assessment. This paper will describe the UMCP component.

In addition to the school and university partners, the BLC also involves a consortium of public organizations and private businesses that have made a major investment in the project. Discovery Communications Inc. participated actively in the development of the original project proposal and is providing digitized video programming from the Discovery Channel and The Learning Channel as well as ongoing technical and conceptual assistance. Apple Computers has donated 40 computers as well as significant technical support. The National Archives and the Space Telescope Institute have provided significant content resources in both digital and non-digital formats.

Overview of System Design

The project employs a multi-format, multi-source approach to providing a wide range of instructional materials in content classrooms. When the project is fully implemented, 12 science and social studies teachers in classrooms in three urban middle schools will have access to still images, various forms of text, WWW sites, and full motion video via high speed connections to the Internet. Some of these resources will reside on a video server consisting of a Sun Sparc 20 workstation running Starlight video server software while other resources will reside throughout the World Wide Web. The project is employing a client-server configuration with client machines installed in the middle school classrooms and digital resources available on a download basis from the server. Upon final implementation, video streaming will be supported, with all resources available "on demand" from the server or the World Wide Web.

Each of the 12 classrooms is equipped with three or four Apple Macintosh 5200 computers capable of displaying MPEG video. These machines are available for student use. In addition, the classrooms also include "planning and presentation" platform consisting of an MPEG-capable Apple Macintosh 5400 computer equipped with a 4gb hard drive as well as one or two large screen "s-video" monitors for classwide display. Presently, each of the schools in the project operates an ethernet-based LAN with a hubbed dial-up connection to a proprietary Internet provider. All teachers on the project also have been provided with Internet access at home. The project will migrate to fiber or a hybrid wired/wireless solution in the last two project years. Currently, the Sparc 20 server resides at the University of Maryland but upon full implementation of the project, the server will be located in the school district and schools will have ISDN or better bandwidth connectivity.

The networking and video-server configurations employed on the project for the most-part use "off the shelf" technologies. This is consistent with the goal of ensuring maximum scalability of all aspects demonstrated on the project. However, the project has required development of two software innovations. These are an indexing system that employs a graphic display for retrieval and previewing of digital resources, and a user interface that links access and use of digital content resources directly to an instructional decision-making and planning process based on curriculum standards. The customized search and explore interface uses a dynamic query interface [Allany & Shnierderman, 1995] to support teacher access to the resources.

Multimedia Indexing and Retrieval System

The multimedia indexing and retrieval system employs a starfield display that allows the user to search for digital resources stored on the local server by subject area, topic, or subtopic. The display crosses topics by standards on two axes and displays variable length bars corresponding to video, graphics, WWW sites, and text resources, and modules previously created by other teachers. The number of each type of resources available on the server varies according to the particular subject area, topic, or subtopic selected and the size of the bar displayed in the starfield corresponds to the number of resources of each type that are available for retrieval. This display is illustrated in Figure 1. Currently, over 1000 objects are stored on the server, and we anticipate that this number will grow to over 50,000 by the end of the five project years.

By clicking on any of the bars in the starfield display, the user can obtain more detailed information about the resources available and then select specific items to preview. The preview mode presents thumbnail images of the resources available on the server so the user can decide whether or not they want to acquire the image for use in the classroom. The preview mode is illustrated in Figure 2. Once the user has decided to use an item, it can be downloaded and stored at the planning and presentation workstation in the teacher's classroom.

Instructional Planning Interface

The overriding goal of the project is to create technological support for instruction in middle school content classes that enables students to meet rigorous performance outcomes. The digital materials that can be accessed in the project are expected to function as instructional anchors that will help teachers create a context within which to situate instruction. Unlike videodisk-based programs in which instructional planning and organization are conducted by the program authors, this project leaves virtually all of the decision-making about how the digital resources will be used up to the teacher. Generally the video content stored on the server is less than 3 minutes in length and is intended to be used within an instructional

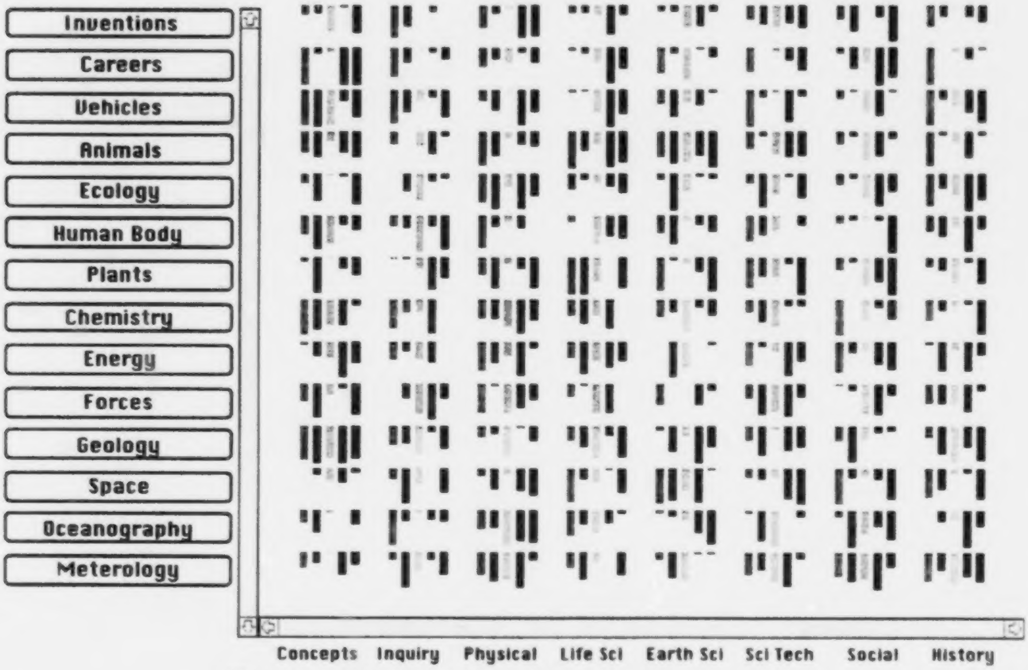
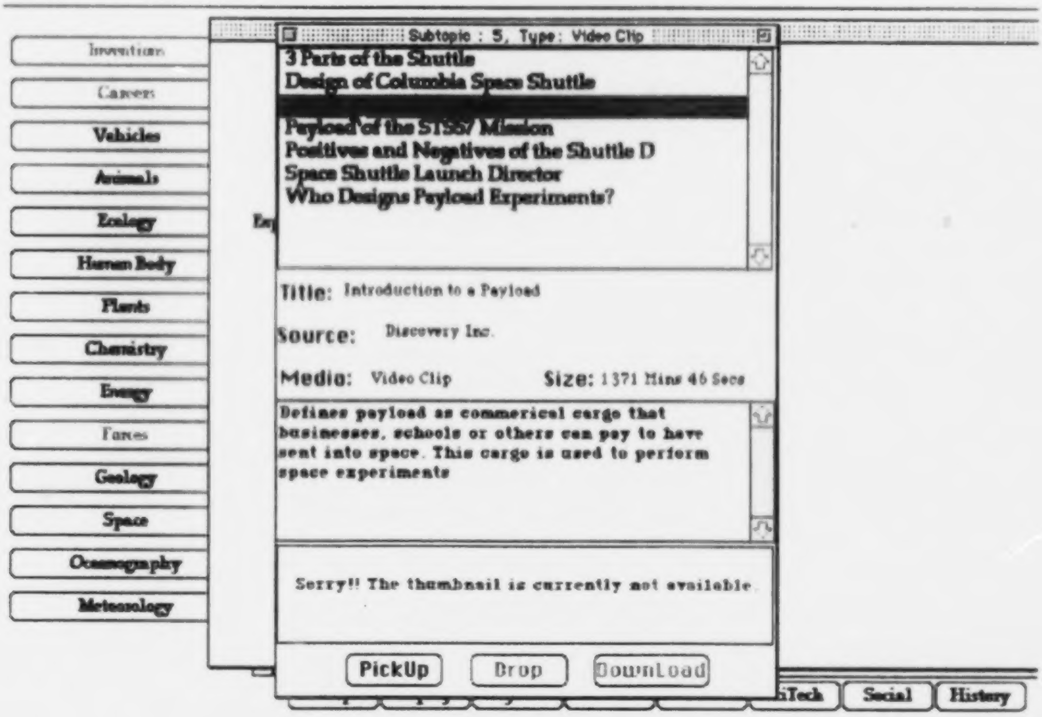

Inventions
Careers
Vehicles
Animals
Ecology
Human Body
Plants
Chemistry
Energy
Forces
Geology
Space
Oceanography
Meterology
Concepts
Inquiry
Physical
Life Sci
Earth Sci
Sci Tech
Social
History

Figure 1: Starfield display indexing and retrieval system


Inventions
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Ecology
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Plants
Chemistry
Energy
Forces
Geology
Space
Oceanography
Meteorology
Subtopic : 5, Type: Video Clip
iTech
Social
History
PickUp
Drop
Download

3 Parts of the Shuttle
Design of Columbia Space Shuttle
Payload of the STS57 Mission
Positives and Negatives of the Shuttle D
Space Shuttle Launch Director
Who Designs Payload Experiments?

Title: Introduction to a Payload

Source: Discovery Inc.

Media: Video Clip Size: 1371 Mins 46 Secs

Defines payload as commerical cargo that businesses, schools or others can pay to have sent into space. This cargo is used to perform space experiments

Sorry!! The thumbnail is currently not available.

Figure 2: Starfield display preview mode

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context mediated by the teacher rather than to function as a complete instructional program. To assist teachers in this process, a user interface has been created that requires a series of instructional planning decisions before the digital resources stored on the server are incorporated into instruction in the classroom. The interface is an HTML-based form with cgi scripts that support development of Instructional modules that can be stored on the server and displayed at the planning and presentation workstation in each classroom.

Instructional modules can then be used in any context the teacher wishes, ranging from a single, self-contained lesson to a series of lessons that occur over numerous class days. These modules are stored on the server and always available for use in the classroom. The user interface offers a Planning Mode and a Presentation Mode to support module development. To create a module during Planning Mode, the user must specify specific information such as grade level, content area, and curriculum goals the instruction is intended to address. The Planning Mode interface is shown in Figure 3.

Linkage with performance assessment tasks also will be included in the final version of the system, although this function is not included in the current version. The user also is asked to identify activities and tasks that will occur before-, during-, and after-instruction. Once this information has been specified, the path name or URL of resources the user has selected from the starfield display are listed and available for display in the classroom. When the teacher is ready to use the module in class, the resources can be accessed from the list and displayed via the TV monitors. The Presentation Mode permits resources to be displayed in full motion, at full screen under teacher control.

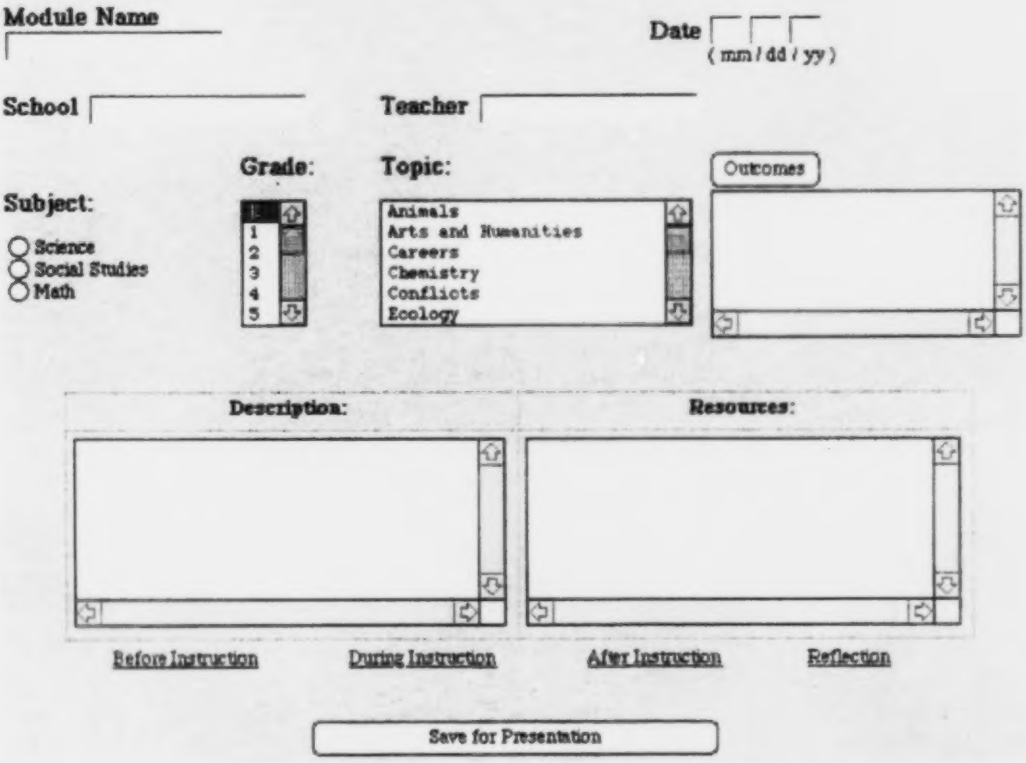
Module Name
Date
(mm / dd / yy)
School
Teacher
Grade:
Topic:
Outcomes
Subject:
○ Science
○ Social Studies
○ Math
1
2
3
4
5
Animals
Arts and Humanities
Careers
Chemistry
Conflicts
Ecology
Description:
Resources:
Before Instruction
During Instruction
After Instruction
Reflection
Save for Presentation

Figure 3: Instructional planning mode in user interface

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Motivating and Retaining Students While Enriching Their Learning Experience: Just-in-Time Learning With the World Wide Web

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Abstract: Successful teachers have always been able to create an environment in tune with the learning styles of their students. Today's students span all ages and have varied learning styles and backgrounds. Many work under serious time constraints, want to control their learning process, and care that the classroom experience connects to the real world. Today's teachers can make use of scientific educational research which underpins modern pedagogy and electronic communication which expands the classroom into a collaborative, interactive learning environment.

We have significantly improved student morale and performance through a strategy combining collaborative learning with use of the world wide web. Students submit web-based active learner assignments. A subset of these assignments, due just before class, provides immediate feedback concerning the state of the classes' progress. Instructors adjust the subsequent lesson to address the specific student needs revealed by this electronic communication. We have designated this technique Just-in-Time instruction.

Introduction

IUPUI and the USAFA faculty face very similar challenges. The students at both institutions expect course material to be relevant to their career objectives. They work under severe time constraints, and come with a wide range of backgrounds, interests, and academic preparation. To meet these challenges, we turn to the fruits of developments in communication technology of the electronic information age and physics education research.

The digital electronic information age opened with the advent of the microprocessor-based personal computer in the late 1970's. The next phase came with the introduction of multimedia objects such as digital images, digital video and sound. The third phase, the World Wide Web, has become the vehicle for rapid dissemination of multimedia learning resources. The web technology also provides for instantaneous interactivity, essentially eliminating the traditional space and time barriers. Web sites can serve as communication hubs for student-teacher, student-student and teacher-teacher interactions. By providing web-based instructional material teachers can structure the out-of-the-classroom time so the students can use it more productively. Web sites can provide a virtual setting for collaborative peer instruction which has proven so effective in the classroom.

Education research [Redish 1994, Peters 1982, Cope and Hannah 1975] has identified a number of challenges that impede effective teaching and learning. For our students, the most significant of these are: time management, motivation to learn physics, physics vs. the real world, study habits, and academic background.

In addition, a successful career in a technical workplace necessitates the development of critical thinking, good estimation skills, the ability to deal with ill-defined problems, cooperative work habits and communication skills.

The Challenge

Indiana University-Purdue University at Indianapolis (IUPUI) is a public university in an urban setting. It is a major campus in the statewide system of Indiana University with an enrollment of over 27,000 students. Just under 20,000 of these are undergraduates, while the rest attend professional and graduate schools. 12,722 students are full time, 58% are female, and 11.8% belong to ethnic minorities. 79% of the students are employed, most of them (88%) off campus. The average age of the IUPUI student is 26.8 years.

The United States Air Force Academy (USAFA) is a residential four-year military college in a rural setting. The total enrollment is 4,000; about 1,200 fourth class (freshman) students enter each year. The composition of the student body mirrors that of the Air Force officer corps: about 12 percent women and 16 percent minorities. Students come from all fifty states and several other countries. Their common bond is the desire to be military officers.

Physics educational research over the past two decades suggests promising strategies to help students benefit more from their classroom experiences [Redish 1994, Peters 1982, Cope and Hannah 1975]. Students in physics classes must be given control over their own learning processes, must be motivated to want to learn physics, and must be shown the connection between physics in the classroom and the real world. At the same time, they have to acquire critical thinking skills, estimation skills, and problem solving skills, and they have to master a great deal of physics content.

In introductory physics at IUPUI, we deal with all of these challenges. In addition, there are difficulties posed by a student body that is primarily composed of students who are commuters, who have poor academic backgrounds, and who are returning to or first entering higher education after several years in the workforce. Most of our students are on split schedules: in school in the morning, at work in the afternoon, and perhaps back in school in the evening. Although our students are older and more mature than those found at many colleges and universities, they often have poor study habits, and many have mathematical skills that have grown "rusty" since their last educational experience. For these and other reasons, most of our students have little self confidence. Retention is a major problem as a result of these pressures. Commuting students, who are often part-time students as well, have a particularly hard time staying the course. They frequently give up early in the semester only to come back and try again the following semester. Even intelligent, motivated students often must repeat one or both semesters to earn passing grades. Other, less motivated students may question their ability and give up on their educational goals altogether. These problems are not unique to IUPUI or to science and engineering: high attrition rates are common among students returning to higher education nationwide [Cope and Hannah 1975].

At the USAFA, we find that some of our students aren't spending as much time on physics outside of class as the faculty think they should be spending. In other cases, we find that our students are spending a good bit of time, but that the time they are spending isn't very effective or efficient. In many cases, the cause of the problem can be traced to severe student time constraints and limited feedback and support mechanisms outside the classroom. Although the reasons for the USAFA student time constraints -- namely an ever present combination of academic, military, and athletic duties -- are different from those of civilian institution students like those at IUPUI -- namely jobs, families, extracurriculars -- the effects are the same. Furthermore, although our faculty are very available during the day, time-constrained cadet schedules force much of their study into evening hours when faculty are generally not available.

Every one of the 4000 Academy cadets must take and successfully complete two semesters of calculus-based physics. Although each of the cadets excels in one or more academic disciplines, not every student necessarily excels in or is inherently interested in physics; so they often wonder, "Why do I have to take this?" and "How is this relevant to me and/or my Air Force Officer career?" Our efforts try to address and answer these questions. In doing so, we hope to personalize our physics courses by using the same technology that is sometimes criticized as being impersonal.

Meeting the Challenge

The last ten years have seen a number of innovations in introductory physics instruction. Physics courses that produce desirable results all have broken with tradition in one way or another. While our experimental, innovative courses retain the traditional format, they have broken with tradition in several ways. Both the structure of the courses and the instructional strategies have been changed.

Our efforts are founded on a two pronged approach combining technological methods (the web component) with intense personal contact (primarily a collaborative learning environment in place of the traditional recitation section and timely monitoring of student status via the web assignments.) We have added an active learner, around the clock, component delivered on the world wide web, and we have adopted our own version of collaborative learning.

The structural redesign represents a shift to the active learner paradigm grafted onto the traditional lecture/lab/recitation format. The new instructional strategies focus on the problems we have identified in our student populations.

We want to be able to move toward and accomplish individualized learning. We want to be able to start where each student is and help them advance from that point by providing appropriate levels of support and feedback, thus producing enabled students.

We also want to be able to move toward and accomplish interactive learning. We want collaborative student/teacher sessions, and class meetings that engage the students rather than allowing them to remain passive.

Furthermore, we want to be able to move toward and accomplish real-world, relevant learning. We want our students to know how the physics content they learn in physics class is relevant to their careers as science literate citizens/Air Force Officers.

It is important to understand that our use of the web is not intended to reduce the demands on instructors' time, nor is it intended to increase the number of students that can be handled. If anything, the role of the instructor and the involved commitment to individual student needs become even more important.

The web component of the course is intended to address several of the challenges discussed above. It gives students more control over their learning process, provides information connecting the course material to real world phenomena, gives commuting and part-time students an enhanced connection to the learning community, and can be used to provide remedial materials. Furthermore, the web based assignments are carefully constructed and paced so as to provide motivation and aid in study time management. By systematic use of the emerging network technologies, it is possible to break down the space and time barrier and connect to the student outside the classroom at any time.

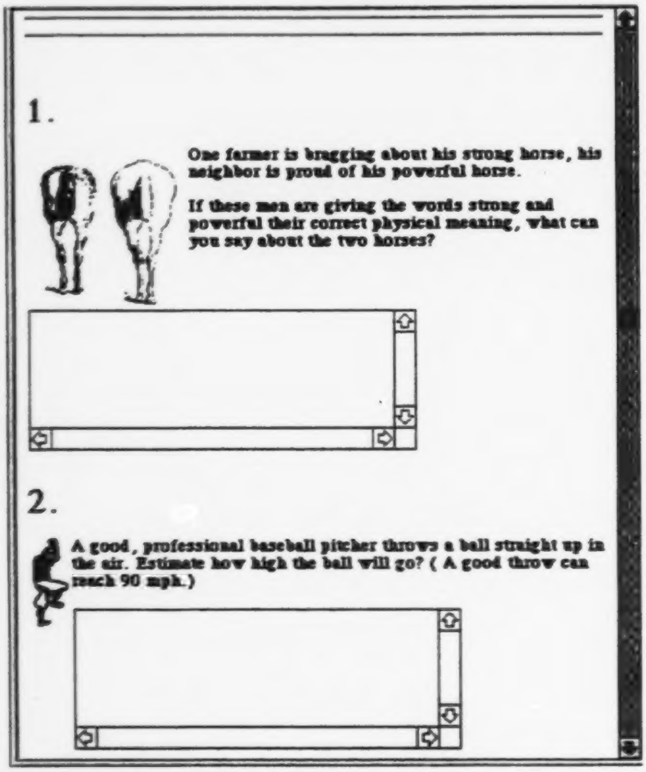
A crucial aspect in the success of our web component has been the offer of "extra credit" through the web material. Three separate pages within the material offer credit: "What is Physics Good For?", Warmup/Preflight exercises, and the Puzzle. We refer to these assignments as "extra credit" for a specific reason. After informally interviewing several students, we concluded that students would not visit the material unless there was a direct academic incentive. We did not wish to reduce the amount of traditional homework; however, students will resent the assignment of extra "required" work if it is imposed with no concomitant increase in the number of credit hours earned. Offering "extra credit" answers both of these concerns, while simultaneously improving student morale.

Each of the web assignments has different educational goals. However, the web assignments also work together in several important respects. By scattering the credit over several different pages, we encourage students to work on physics frequently and in short sessions, a far more effective study habit than a single weekly "cram session." Furthermore, we cash in on the "arcade factor" identified by some education researchers [Malone 1981]. Giving the student multiple chances encourages the student to try again and eventually succeed. This encourages the student to keep up with the course and mitigates the impulse to withdraw because "I am so far behind." Since most of our students respond to these assignments electronically, they are in frequent one-on-one contact with their instructors. Requests for clarification of a particular topic often accompany the their submissions. It may seem paradoxical that the use of electronic technology should enhance personal relationships. However, this phenomenon is not unusual in on-line activities.

The web component also provides crucial feedback to the instructors. One set of web exercises (the "warmup"/ "preflight" exercises, which we discuss in detail below) give the instructors insight into the state of students' knowledge and into the misconceptions that many students bring to the study of physics. This allows instructors to adjust the subsequent lesson to address the specific student needs revealed by this electronic communication. We have dubbed this method Just-in-Time (JiT) instruction, in analogy with JiT production methods now used by many industries. The comparison is not capricious. In both cases, the JiT system improves flexibility, minimizes waste, and provides rapid reaction to unforeseen demands.

These exercises are due a few hours before class. Each includes three questions: the first is conceptual, requiring a response of a few sentences. The second question calls for the student to do a brief calculation including an estimation task. The third is a single-concept multiple choice question.

These exercises are the heart of the Just-in-Time instruction system. Each morning before class the instructor reads the student responses, then has a few hours to adjust the lesson to respond to the students' demonstrated knowledge. Thus far, we have found that the conceptual questions are particularly valuable for JiT instruction. Most instructors (ourselves included) easily forget the misconceptions that many students bring to their first contact with various concepts in physics. As an example, consider the words force, power, and energy.



1.

One farmer is bragging about his strong horse, his neighbor is proud of his powerful horse.

If these men are giving the words strong and powerful their correct physical meaning, what can you say about the two horses?

2.

A good, professional baseball pitcher throws a ball straight up in the air. Estimate how high the ball will go? (A good throw can reach 90 mph.)

Figure 1: Warmup/Preflight exercise from first semester physics

These are generally considered to be synonymous; this document was prepared using a word processor that lists them as such in its thesaurus. However, in physics, these words all have special meanings and the quantities cannot be equated. Students, pressed for time, often miss this fact on a first reading of the book. A warmup/preflight question asking that the students discuss these concepts will motivate many students to reread a few sections. The remainder answer the question based on their preconceptions. These answers (presented in anonymous, edited form) can be used as talking points during the lesson, while the issue is still fresh in the students' minds.

Additional web material provides support and framework, as well as additional relevance and connection to the real world.

The "This Week" page includes course announcements and frequently provides brief notes (with links to outside sources) concerning news items of scientific interest. The button bar on the left edge of the page provides links to several more pages on which the primary content is provided. This page and all that follow from it are completely updated each week.

The "What is Physics Good For?" page serves several of the goals stated above. It is our primary vehicle for connecting classroom theory to real world phenomena. It is also extremely valuable as a motivational tool; it allows us to introduce both the excitement of recent scientific developments and the importance of familiar technological devices into a curriculum that is traditionally limited to the results of the 17th and 18th centuries. The page introduces a subject and establishes a connection to the subject matter being treated in class. These subjects have included, Life on Mars, Electric Vehicles, Superconductivity, Auto Racing, and The World Wide Web itself. After one to two pages written by the instructors, links to outside sources of information are provided. The students are then asked to check these links, use search engines, and respond to a few short questions concerning the week's subject. They submit their results to the instructors via e-mail. This assignment allows the students to explore these topics at their own pace. We have found that students frequently exceed the stated questions, providing unsolicited information often including suggested links for future pages.

As the name implies, the "Puzzle" page presents a physics scenario with an extra twist that requires the student to see beyond the end-of-chapter formulas. This is often accomplished by further challenging commonly held misconceptions. The Hestenes' Force Concept Inventory questions [Halloun and Hestenes 1985] and Eric Mazur's peer instruction questions [Mazur 1996] have a similar character. These questions may appear quite trivial to a physicist, indeed, they may almost always be answered with no need for mathematical calculations. On the other hand, they usually present a significant challenge to the beginning student.

Following the puzzle, the remaining pages offer preparatory materials associated with the weekly lab section, the archive of previous materials, and the "credit check." This last allows students to determine which web assignments they have received credit for, and gain a sense of how they are doing with respect to their classmates.

The last page is the "Hot Stuff" page. This includes materials which are of immediate import. For instance, sample exams are posted here during the week before each test, and the grade distributions are posted after the tests. In addition, breaking scientific news items are posted here if they require more space than a few lines among the announcements.

For the future, we intend to expand and improve our use of the web in several important ways. We will introduce remedial materials in the areas of trigonometry, vector algebra, and basic calculus. This will be particularly valuable to our returning students, many of whom are 5 to 10 years from their last mathematics course. We will expand the laboratory preparation page to include short streaming video clips of the upcoming experiment. This lab prep page already includes an extra credit component related to a data analysis tasks they will face in the lab. We have begun to use student mentors to supplement faculty in the recitation classroom. We have one such student now, and he has made a markedly positive impact. Certain types of advice are simply more acceptable coming from another student, especially as the student is known to have no grading responsibilities.

We have anecdotal evidence that the system is working well. At IUPUI, attendance in the classroom has jumped to 95%. The early withdrawal has virtually disappeared. That means that we are retaining students who, in previous years, dropped the course for psychological reasons and eventually passed. We are still looking at a 10 to 15% attrition rate in the first course and 5% in the second course. This represents students who withdraw at midterm or fail the course. We consider this an acceptable rate. Some of these students start out in the wrong program. About 60% of the students in the first course and 95% in the second course submit material to the web. Virtually all of them visit the web site. At the USAFA, the JiT approach is being tested in a number of sections. Submission response percentages range from 65% to 100%. Anecdotal evidence suggests that student attitudes toward physics are improving. Instructors appreciate the unprecedented JiT access to the wealth of information about their students' progress.

After another semester or so of fine-tuning, we shall proceed to a formal assessment of cognitive gains, if any, which result from Just-in-Time instruction.

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Evaluation of a Wearable Computer Performance Support System

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Abstract:
It has been proposed that performance support systems can improve the speed and quality of learning by providing the right information when and where it is needed. However, there have been no formal studies comparing a performance support system to traditional training or support methods. This paper describes an initial study which compared a computer-based performance support system with a book for learning and performing a simple task. Results of this initial study are summarized. Guidance on the design of future performance support systems and suggestions for future studies are also provided.

Introduction

Performance support systems are computer information systems which are designed to improve employee performance. Performance support systems aid performance by providing only the necessary information at the right time and supporting training when training is needed [Gery 1991]. Performance support systems allow all employees to have expert-like performance. However, not all jobs are computer-based; many workers are mobile and do not use a computer to do their jobs. In these situations, using a wearable computer to deliver a performance support system can improve the effectiveness of the performance support system. In particular, a wearable computer performance support system can:

- Provide training and support *when* the learner needs it
- Provide training and support *where* the learner needs it
- Provide only the information that is needed at that time
- Allow the learner to control any training that is required
- Provide multimedia (e.g., text, audio, drawings, video) presentation which most effectively communicates the information needed
- Emphasize performance rather than knowledge
- Eliminate time between learning and application of knowledge
- Provide hands-free operation
- Allow the learner to see both the work environment and the presented information simultaneously

The use of a wearable computer with a performance support system is a novel concept in performance support [Ockerman, Najjar, Thompson, Treanor, & Atkinson 1995]. To determine whether a wearable computer performance support system can help people perform tasks, we performed an initial evaluation. In the evaluation we compared the use of a wearable computer performance support system to the use of a book to perform three simple tasks. To evaluate the effectiveness of the wearable computer and performance support system, we developed a wearable computer and a simple performance support system. Each of these technologies is described in the following sections.

Wearable Computer

Figure 1 shows a front and back view of the wearable computer's major components. The user enters and receives information from the computer using a combination microphone/earphone and a head-mounted display. Voice recognition serves as the primary way to control the computer. The computer and batteries are worn on the waist.

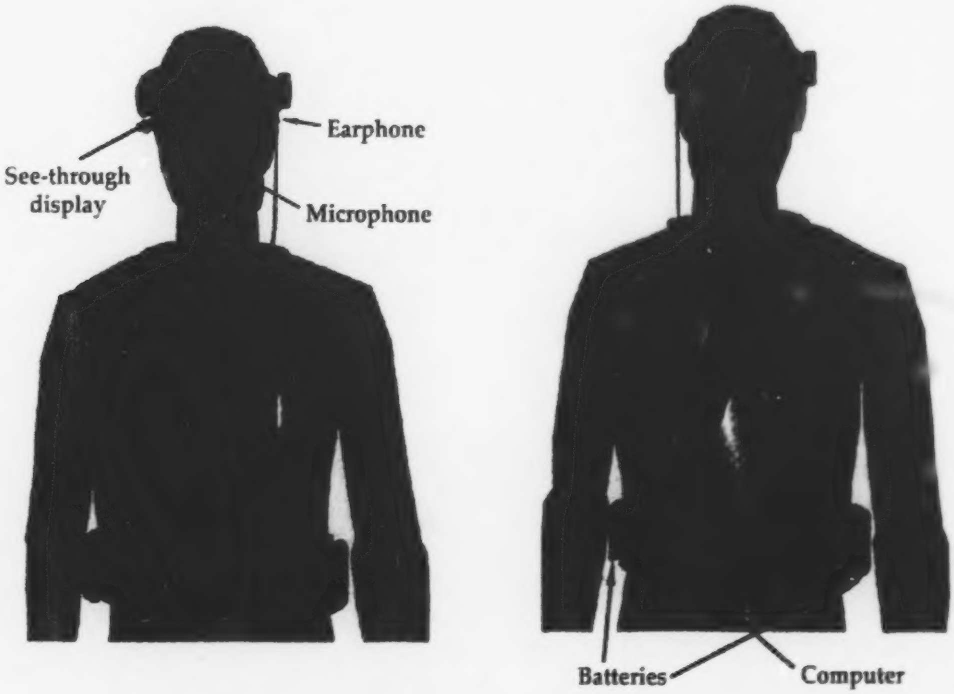

Figure 1: Front and back view of wearable computer components.

Our wearable computer provides many advantages for helping a user to perform tasks. For example, the display allows the user to work while looking at text, drawings, and video. The earphone allows the user to hear explanatory audio narration while looking at information on the display or at the task environment. The microphone, voice recognition software, and our applications allow the user to control the computer via voice so the user's hands are free for other tasks. The computer allows the information designer to use the best medium (e.g., text, graphics, video, sound) to communicate information to the user. The combination of batteries, computer, wireless network, and head-mounted display allow the user to be mobile, getting information when and where the user needs it.

Performance Support System

Performance support systems use specialized software which integrates information, tools, and methodologies to help a user perform a specific task [Gery 1991]. We built a performance support system to teach users how to do origami, the ancient Japanese art of paper-folding [Najjar, Ockerman, Thompson, & Treanor 1996]. Origami is a hands-on, slightly complex task which is unfamiliar to most people. The goal of our system was to allow users to learn to fold a simple jumping frog.

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To be successful, a performance support system must organize information in a way that is obvious to someone who has not used the performance support system before [Najjar, Ockerman, Thompson & Treanor 1995]. We organized the training information into the following intuitive categories: a brief description of the training goal, the steps to follow to meet the goal, a tool that helps the user correct his or her work, and an on-line library of background information. Figure 2 shows the main menu of our origami performance support system.

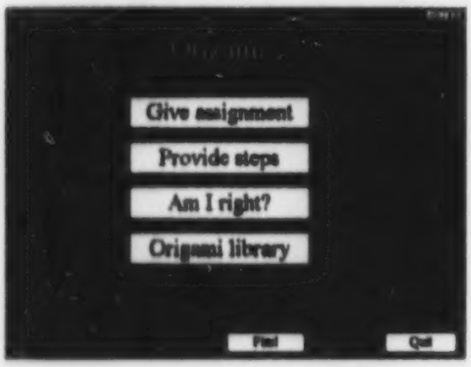
Give assignment
Provide steps
Am I right?
Origami library
Find
Quit

Figure 2: Main Menu of Origami Performance Support System

In our origami performance support system, we tried to use media in a way that helped the user to understand and learn the information [Najjar 1995, Najjar 1996]. For example, in the section that has step-by-step instructions, each step is illustrated with a simple static drawing and accompanying auditory instructions [see Figure 3]. To understand the fold described by the step, the user can examine the drawing for as long as desired and have the instructions replayed. However, since paper-folding is a dynamic task, we also provided an option that allows the user to see and hear a video of someone actually folding the paper [see Figure 3]. The wearable computer allows the user to look at the drawings or videos, and listen to the auditory instructions, while folding the paper.

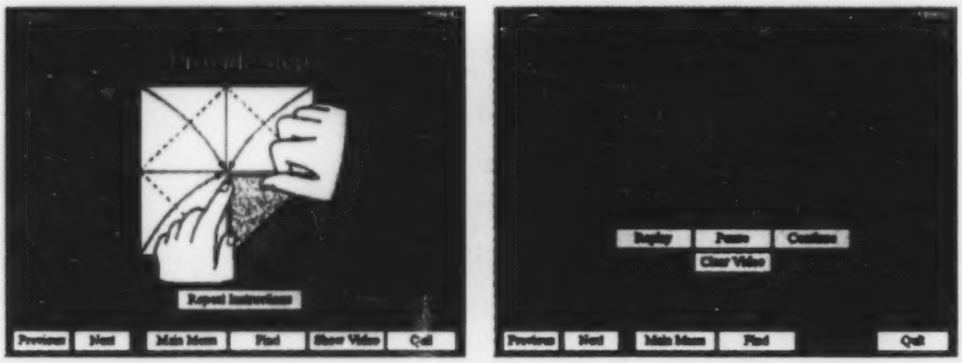
Repeat Instructions
Previous
Next
Main Menu
Find
Show Video
Quit
Replay
Pause
Continue
Clear Video
Previous
Next
Main Menu
Find
Quit

Figure 3: Sample Step from Origami Performance Support System (static drawing and video)

Method

This initial study compared participant performance in three simple tasks while using one of the following two learning systems.

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- A wearable computer performance support system. The wearable computer shows drawings, audio, and video which demonstrates how to fold a jumping frog. The user also provides basic origami information (e.g., common origami folds and information on origami paper). The user controls the navigation and pace of the instruction with voice commands.
- A book. The book includes textual instructions and black and white drawings to show how to fold many objects and provides basic origami information. The user controls navigation and pace of instruction by flipping pages.

The verbal instructions and static drawings on how to fold a jumping paper frog are identical in both systems. Participants were not given any explanation or prior practice using the learning system they were assigned.

Participants

Twenty professionals and students from Georgia Tech participated in the study. All of the participants rated themselves as 'very inexperienced' or 'inexperienced' in origami on a background questionnaire. The participants were randomly assigned to one of the two learning systems groups (computer or book) with 10 participants in each group.

Procedure

The participants first completed a background questionnaire to determine their level of experience with origami. Then, using the learning system to which they were assigned, the participants completed three tasks: (1) fold a paper jumping frog, (2) find the term "squash fold," and (3) find the meaning of the word "origami." After completing the three tasks, the participants rated their learning system on a final questionnaire.

Measurements

For each of the three tasks, both speed and accuracy were recorded by the experimenter. The experimenter recorded by hand the actions of the book users while an electronic log file was kept of each of the computer user's actions. The participants also provided subjective measures of the two learning systems by rating their learning system on a final questionnaire.

Results and Discussion

Objective Measures

One-tailed t-tests were conducted on the speed data from all three tasks. On the first task, folding a paper frog, the book users were significantly quicker than the computer users (*book mean = 241.9 sec., computer mean = 384.7 sec,* $p < 0.05$). Although we had hoped that the computer would be more comparable to the book, this result was not surprising for several reasons. First, it takes longer to go through the computer steps, particularly if videos are viewed. It also takes longer for the user to listen to the auditory instructions than it does for a participant to read the instructions. Second, the task was simple enough that the instructions were on only one page of the book. The book users were not required to turn pages to get to the next step, whereas the computer users had to say "next" for the next step. Finally, the book users could look ahead in the instructions, and in some cases did not even read the instructions. This look-ahead ability also helped them to figure out how to make a confusing fold because they could easily compare before and after fold illustrations.

There was not a statistically significant difference between the book and computer users' performance on either of the information location tasks. For the second task, locating the term "squash fold", the book users were slightly quicker (*book mean = 31.6 sec., computer mean = 44.8 sec.*), while for the third task, locating the meaning of "origami", the computer users were slightly faster than the book users (*book mean = 21.7 sec.,* *computer mean = 18.3 sec.).* These were surprising results to us. We expected the computer users to be significantly faster, due to the speed of the computer and not having to turn pages. However, the book was small and participants were very familiar with the typical layout of a book (e.g., table of contents, indexes, and introductions). Also, many of the computer users did not use the "Find" function provided in the computer performance support system. Even though there was a "Find" button on every page of the performance support system, many participants either did not see it or did not think it would help in their current task. In many cases the computer participants fell back on their knowledge of books and would go though the pages of the Origami library. It was while paging through the library section that some users finally noticed the "Find" button. Perhaps the use of a "Find" function makes more sense in a library than in the entire performance support system.

The second objective measure was accuracy of completing the first task, folding a paper jumping frog. Inaccuracies were broken into two categories, those inaccuracies which would have no effect on the final product and those which would affect the final product. Along with inaccuracies, we also computed the ratio of fixed mistakes to total mistakes. The last category was the number of participants who made at least one mistake of either type while completing their frog. It was expected that the computer users' performance would be better in all of these categories (i.e., have a lower number) than the book users' performance due to the ability to look at videos of each step. In all but one case we were correct as shown in Table 1.

Category	Book	Computer
No effect mistakes	7	4
Mistakes with an effect	3	5
Ratio Fixes to Mistakes	10/4 = 2.5	9/5 = 1.8
At least one mistake	7	5

Table 1: Results of accuracy measurements

However, only three participants even used the videos, so it seems unlikely that the ability to see a step done was the reason why computer users made fewer mistakes than book users. Also, two of the people who looked at videos made mistakes. Finally, the computer users made more mistakes that would affect their final outcome than the book users. It appears that more research is needed in this area.

Subjective Measures

There were four, five-point (1=low, 5=high) rating questions on the final questionnaire. The average ratings for the book and the computer are almost identical as shown in Table 2.

Questions - Please rate...	Book	Computer
how much you liked or disliked using the learning system.	3.9	4.1
the effectiveness of the learning system for helping you perform the paper-folding task.	4.3	4.3
the effectiveness of the learning system for helping you to perform the word search tasks.	4.4	4.4
the likelihood that you would want to have this kind of learning system if you had to learn to do paper-folding (origami).	4.2	3.9

Table 2: Results of subjective ratings questionnaire

These results were a little surprising since we thought that the participants would like the computer performance support system better than the book. We were surprised at the high ratings on the book. We thought that the book users might become frustrated and have no way to get around their frustrations since there were no videos. However, it appears as if the task was too simple to take advantage of the video feature of the computer performance support system.

From written comments it appears that the computer users would like the system on a desktop computer but did not enjoy using the head-mounted display. This probably affected their rating of the entire system to some degree.

Conclusion

This initial study highlighted many important issues with the wearable computer performance support system. These issues range from design of the human-computer interface to experimental design. We identified many ways to improve our interface, and offer these as suggestions for future designs of task support software. It is obvious that users fell back on their knowledge of paper books in order to interact with the computer-based system. It would be a good idea to take advantage of this prior knowledge in the interface design. For example, the "Find" button should be labeled "Index". Another possibility is to provide a before and after view of a step in order to confirm that the step was being done correctly. This would provide one function of a video but be much quicker for the user to access. Abilities of the computer system must be clearly marked and noticeable. Neither the "Find" button nor the "Show Video" buttons were used very extensively due to their not being noticed. Perhaps the system should suggest a video after a certain length of time or several requests for repeated instructions.

Wearable performance support systems would seem to be of most benefit to a user when the tasks to be performed are very complex or the environment in which the user must operate prohibits the use of standard materials such as operating manuals. This study did not include these mitigating factors. Consequently, the difference between using the two support systems was minimal. It is encouraging to note in such circumstances that the wearable system did not hinder performance of the user. Future study is planned to verify this hypothesis. Specifically, we will study more complex tasks as well as environmental factors which restrict the use of standard support materials such as books.

Acknowledgment

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The Intelligent Discussion Coordinating System for CSCL Environment

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Abstract: The purpose of this study is to propose a technical and psychological framework of intelligent computer supported collaborative work/learning (Intelligent CSCW/L) which we call "*iDCLE* (intelligent distributed collaborative learning/working environment)". To realize this learning environment *iDCLE*, we constructed the real-time sharing communication system for collaborative work/learning on the computer network. We describe the mechanism for *iDCLE* which supports group learning intelligently in this paper.
In this paper, we describe the fundamental configuration of *iDCLE*, and discuss the mechanism of supporting discussion. The discussion support system in *iDCLE* can identify the state of discussion by tracing our model. The system can also diagnose the process of discussion for the purpose of making progress in the discussion using this model. If any advice is needed after diagnosing, the system gives the appropriate advice to the participants.

1 Introduction

The systems approach of software development by multimedia/networking communication concerns itself with interaction between the system and its environment in consideration of human and technological factors in the distributed remote sites. Whatever methodology is adopted the systems analyst should be aware of the systems approach. The participative approach involves all those people affected by the new system, encouraging user involvement. Effective technical and human implementations by using computer-based systems like CAD/CASE and distance communication systems like CSCW/CSCL is a new methodology based on the participative approach. From this kind of problem awareness, we suppose necessity of the intelligent networking environment to promote software development.

Recently, the networking technology like INTERNET has been developed rapidly and we can communicate and discuss with others in the distributed environment by such technology. Under such a network environment, we can provide and share the various kinds of the educational information like new teaching methods, educational materials, curriculum contents, evaluation methods and computer using in a classroom with foreign country people. Namely, the educational environment is changing from the closed space to global and the open space.

From those problem concerns, we propose the Intelligent distributed collaborative learning/working environment where people can exchange knowledge and solve the problems through group thinking effectively. Many researchers on educational technology attempt to extend the field of study from stand alone learning environment to group learning environment, where multiple agents interact with each other [Baker94, Baker 95, Blandford 94]. The concept of Computer Supported Collaborative Learning (CSCL) has attracted the interest of many researchers by reason of inspecting human dynamic learning behavior in the real situation. This concept is based on the rationales of knowledge constructivism and social situated learning.

Verbal communication seems to play an important part in collaborative learning under networking environment. Students will solve a problem and acquire domain knowledge, moreover they will improve their self/other-monitoring ability and enhance their group productivity through their discussion process. Thus, it seems how to support the discussion process is one of the most important issues in the researches of CSCL. However, it is difficult for the system to recognize the contents of the utterance from students.

In this study, we constructed the framework of our *iDCLE*, where the participant obtains the educational goal through interaction with each other [Inaba96, Okamoto 95]. We classify the information existing in participants' utterance into two categories. One is concerned with the semantics of the utterance. Another kind of information is concerned with his/her intention for making the utterance. We propose the model of transition on dialogue states with the information related to the intention taken from cognitive experiments. We embed the expert system which plays the role of coordinator to support

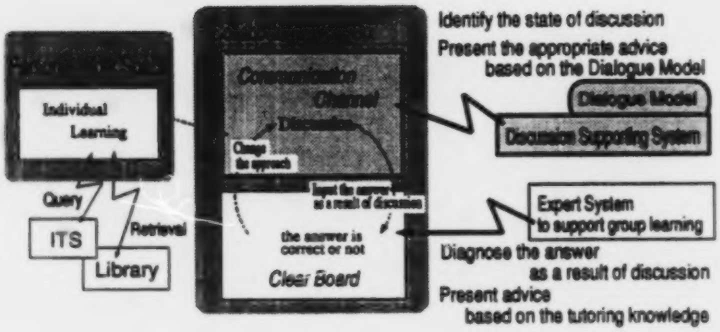
Individual
Learning
Query
ITS
Retrieval
Library
Communication Channel
Discussion
Change the approach
Input the answer as a result of discussion
the answer is correct or not
Clear Board
Identify the state of discussion
Present the appropriate advice based on the Dialogue Model
Dialogue Model
Discussion Supporting System
Expert System to support group learning
Diagnose the answer as a result of discussion
Present advice based on the tutoring knowledge

Figure 1: The Learning Environment

discussion based on the model of transition on dialogue states in *iDCLE*. The system with the state transition model can identify a state of discussion, detect some states in which the system should intervene and give some appropriate advice in consideration of each participant's role on discussion process. We had some experiments to evaluate the system's functions of coordinating the flow of discussion. As a result, it was suggested that the system should have the function to identify the state of collaboration among participants.

2 Research Objectives

Our study has three research objectives as follows.

- To construct a dialogue model of discussion on the computer network.
- To develop an intelligent discussion supporting system which can identify the state of discussion and help their discussion by the model described above.
- To construct a model which represents a discussion process for reaching an agreement.

3 The iDCLE System

In this section, we describe the fundamental configuration of *iDCLE*. *iDCLE* is constructed on the UNIX workstations connected by TCP/IP. The core of its graphical user interface (GUI) is constructed on the X11 window systems.

In *iDCLE*, each participant can freely choose either of two workspaces or both. One is the Personal Work Space, which is a closed private area and cannot be referred by others. This enables the participants to explore their individual information and to learn/work something individually as a performance supporting system. The participant can use several tools for problem solving in this space; e.g., a word processor, a drawing tool, an ITS and so on. Another space is the Collaborative Work Space shared by all participants. This space is used to exchange opinions and to solve problems collaboratively. This space has two places, which are called the Communication Channel and the Clear Board.

[Fig.1] shows the learning environment in *iDCLE*. The participants discuss a given task through the Communication Channel. The discussion supporting system including the computer coordinator can identify the state of discussion and give the appropriate advice by tracing the dialogue model. As a result of the discussion, the participants input the answer to the Clear Board. Here, the expert system diagnoses their answers and gives some advice to coordinate group learning appropriately. If the answer is not correct, the participants may discuss again through group learning and change the answer. An example of the Collaborative Work Space in *iDCLE* system is shown in [Fig.2], in which the participants discuss the geometric proof problem solving. The intelligent tutoring system for geometry (we call the *Geomex-Super*) in this case helps participants prove the geometric theorems in the Clear Board.

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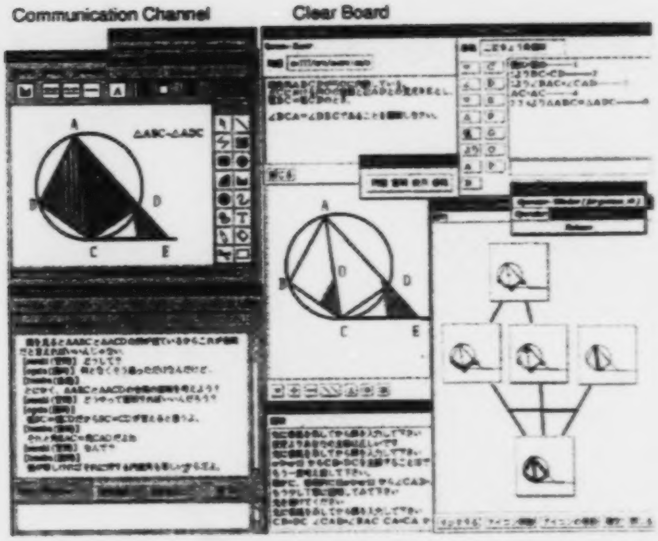

Figure 2: An example of the Collaborative Work Space

The students give their utterance by inputting some sentences to the Communication Channel located on the left side in [Fig.2]. When they finish giving their utterance, they must select their intention from the menu on the Communication Channel. The sequence of inputted intention is stored on working memory in the discussion supporting system. The discussion supporting system diagnoses the state of discussion and identifies a student's role in a discussion process based on the sequence of intention-information on the working memory. Then the system represents appropriate advice on this Communication Channel.

4 Supporting Discussion

As we mentioned above, the discussion on the Communication Channel is supported by the computer coordinator in *iDCLE*. The mechanism of supporting discussion is described in this section.

When each participant makes group discussion about a given problem, the discussion does not necessarily progress smoothly. So a human coordinator gives suitable advice for the state of the discussion process in the real world. For example, when the discussion is progressed by a few participants only, a human coordinator will request another participant, who has not given his/her opinion yet, for something to propose.

We had constructed a discussion support system as a prototype [Okamoto 95]. The system can diagnose four states where the system should intervene. The states are as follows.

- The divergent state of discussion.
- The impasse state of discussion.
- The state in which a participant gives little utterance for a while.
- The state in which a question is not solved.

We had some experiments to evaluate the system's functions of coordinating the flow of discussion. As a result, it was suggested that the system should have the function to identify each participant's role on discussion process. Therefore, we have improved the model of transition on dialogue states and the rule bases on the discussion supporting system which we call the Coordinator system. Next, we discuss the mechanism of coordinating the discussion.

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Table 1: The categories of utterance's intention

Function	*The function of starting a topic*	*The function of expressing a participant's position on other's opinion*	*Other function*
Category	Proposition 1[a]	Agreement	Explanation
	Proposition 2[b]	Disagreement	Answer
	Confirmation		Supplement
	Question		Others

[a] Proposition about a way to develop the discussion

[b] Proposition of next topic for the problem solving

4.1 Model of Dialogue

We propose the model of transition on dialogue states to support group discussion taken from the cognitive experiments. We classify the various kinds of information existing in participants' utterance into two categories. One is concerned with the semantics of the utterance. The information included in this category is related to both the domain knowledge and the context of discussion. Another kind of information is concerned with the participant's intention for making the utterance. Considering a method of supporting discussion, it seems so inevitable that the system utilizes the intention-information included in the participants' utterance to coordinate the discussion flow. We contrived the sophisticated mechanism by which the intention-information can be separated from the contents of a given problem to propose the general purposed framework of *iDCLE*.

The supporting functions of our system are as follows.

- To make users participate actively in the discussion.
- To facilitate group discussion smoothly to the desired direction (such as finding the adequate solution of a problem).

For example, when each participant gives his/her idea and does not say anything related to others' utterance, some advice such as focusing on one issue is needed.

To realize the functions mentioned above, the system should have the function to identify the state of discussion. We classify the participants' intention into ten categories shown in [Tab.1]. We propose the model of transition on dialogue states in consideration of the ten categories described in [Tab.1]. We regard a discussion as the sequential structure of some topics. So, we have only to explore the structure of the transition on dialogue states in a topic. The model of transition on dialogue states consists of four modes: Guide mode, Development mode, Confirmation mode and Query mode. The each structure of four modes is shown in [Fig.3].

The dotted line in [Fig.3] means that there are some conditions to be satisfied for shifting to next state. For example, the condition to shift from S1 to S3 in Development mode is that all students agree with current proposition.

4.2 The model of generating reaction

Satir (1991) suggested a model which represents the internal human process of interaction with the external world. According to this model, a human internal process consists of four elements, that is, intake, meaning, significance and reaction. For information receiving from the external world, a person will interpret the meaning of the information (*i.e.*meaning process), judge the information to be effective in obtaining his/her own goal (*i.e.*significance process) and generate a reaction to the information [Satir91]. However, considering the interaction during a collaborative learning process, a participant will not always decide to accept an opinion when the opinion is effective in obtaining his/her goal. There is a process to decide his/her attitude after the significance process. Here, we propose the model of generating reaction on utterance from other participants in [Fig.4] which consists of three processes.

The participant who receives another person's utterance will enter and succeed in the meaning process and the significance process for the utterance and decide his/her attitude whether he/she will accept it

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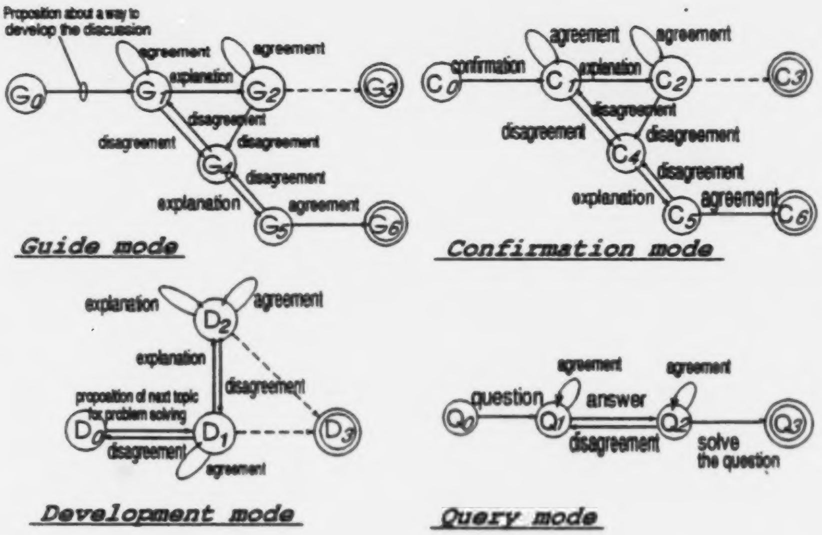
Proposition about a way to develop the discussion
agreement
agreement
explanation
G0
G1
G2
G3
disagreement
disagreement
disagreement
G4
disagreement
explanation
agreement
G5
G6
Guide mode
agreement
agreement
confirmation
explanation
C0
C1
C2
C3
disagreement
disagreement
disagreement
C4
disagreement
explanation
agreement
C5
C6
Confirmation mode
explanation
agreement
D2
explanation
disagreement
proposition of next topic for problem solving
D0
D1
D3
disagreement
agreement
Development mode
agreement
agreement
question
answer
Q0
Q1
Q2
Q3
disagreement
solve the question
Query mode

Figure 3: The model of transition on dialogue state

or not in the most simple interaction. The reaction in such case is classified into reaction *3 or *4 in [Fig.4]. When a participant can not follow the other participants, or there is not enough information to understand the other participants' utterance, the participant can not interpret the meaning of another person's utterance, that is, the participant fails the meaning process and generates reaction *1. When a participant asserts his/her opinion without the grounds, the other people may understand what was said, but not judge the information to be effective in obtaining his/her own goal and generates reaction *2.

4.3 The negotiation process

Now, we try to describe the negotiation process using the three processes mentioned above.

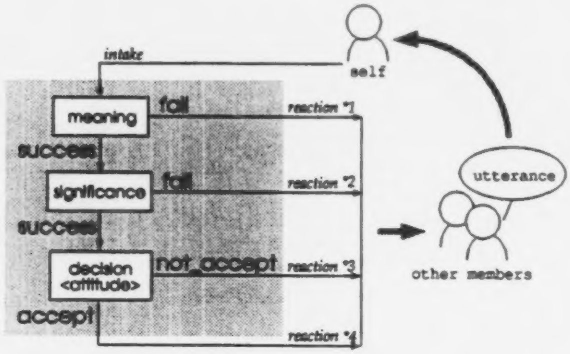
intake
self
meaning
fail
reaction *1
success
significance
fail
reaction *2
utterance
success
decision <attitude>
not accept
reaction *3
other members
accept
reaction *4

Figure 4: Model of generating reaction on utterance from others

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process	*description*	
meaning	*meaning(Agent, Utterance, State)*	(1)
significance	*significance(Agent, Utterance, State)*	(2)
decision	*attitude(Agent, Utterance, Attitude)*	(3)

The *Agent* means a participant who receives utterance from the other participants, the *Utterance* shows utterance as a target, and the *State* shows whether a participant succeeds a process or not.

We suppose the initial state of the negotiation process requires at least that the participants have the common goal of interaction to attain an agreement. There are not always the beliefs or the goals which are conflicted between the participants. The initial state of the negotiation process may be only absence of the other participants' consent to a proposal. We describe the initial and the final state of the negotiation process as (4) and (5).

state	*description*	
initial state	*negoject(Agent, Utterance)*	(4)
final state	*agree(Utterance)*	(5)

The initial state of the negotiation process is set up as the state in which a participant (*Agent*) offers an proposal (*Utterance*) in order to reach an agreement. We call the proposal which is a target of negotiation "*negoject*". The final state means that the negoject (*Utterance*) is accepted by all participants. That is,

```
agree(Utterance):-
     negoject(Speaker,Utterance),
     attitude(Others,Utterance,accept).
```

The `Speaker` means the proposer of the `Utterance`, and the `Others` means the all participants except for the `Speaker`.

5 Conclusions

In this paper, we proposed the model of transition on dialogue states and the model of generating reaction on utterance from the other participants. We contrived the model of transition on dialogue states which utilizes the intentional information included in participants' utterance. The model has the intelligent functions for diagnosing/coordinating flow of discussion on CSCW/L. We have developed an intelligent communication supporting system for *iDCLE* based on this framework. The expert system, called the Coordinator system, can identify and diagnose the state of discussion using the model of transition on dialogue states, and the system can give some advice suitable for the current state of the discussion process.

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Alternative Means of Internet Access: Enabling Financially-Strapped Public Schools

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Abstract: Models for low-cost internet access are being developed through a partnership of universities, public schools, corporations, and local businesses in Georgia. Utilizing microwave technology, internet service is being extended from two universities to one inner-city and one rural school. These technology designs could serve as models for future, statewide initiatives to wire public schools to the internet. While one focus of the project is technological, another is pedagogical. This project also involves university researchers working with public school teachers to develop classroom activities and projects utilizing internet resources. Students will be expected to gather information from the internet to inform the design of real-world scientific experiments and create web pages to describe their findings. Pedagogical goals are to support student efforts at working with the scientific method, help students develop problem-solving and reasoning skills, and provide students with experience in using technology to support their learning.

Introduction

Access to innovative, state-of-the-art instruction need not be restricted by traditional notions of geographic boundaries, curriculum, facilities, or local expertise. Advances in telecommunication technologies and distance learning research and theory make possible teaching and learning opportunities that are currently unavailable in all but a few live, site-based learning environments. With high speed networking technologies and advanced telecommunications becoming interactive through two-way carrier technology, learning at a distance is being transformed.

A research project utilizing the instructional experience and technical expertise of three major universities (The University of Georgia, Clark-Atlanta University, and The Georgia Technological Institute), the funding of the Georgia Research Alliance (GRA) and AT&T, and the support of local businesses (e.g., cable, communications) is underway in the state of Georgia. Referred to as "Science Connections: Problem Solving at a Distance," this project aims to demonstrate new, low cost solutions to accessing the internet for public schools. Improved access alone, however, is insufficient. Significant advances have been made, not only in the ability to transmit data and images, but in developing distance learning environments that are based on emerging theories in teaching and learning. Contemporary perspectives emphasize authentic learning environments as individuals develop an understanding of content as well as metacognitive skills to support and transfer learning for other tasks. The focus of this project is therefore both technological and pedagogical. Two test sites have been identified and are being linked to the internet for this demonstration project: a high school in urban Atlanta and a middle school in rural Georgia.

Technological Barriers and Solutions

Currently, schools in Georgia and across the United States and Canada are struggling to "wire" their classrooms and media centers to the internet. Expensive T-1 lines and fiber optic cabling are simply too cost-prohibitive for public schools with limited technology budgets. In an effort to remedy this problem, it is possible to employ new technologies, and some old ones, that serve the same purpose as expensive hard-wiring.

Providing schools with non-traditional access to the internet is not the key problem for this project. A number of solutions are available which simply provide access. For instance, internet resources can be provided to schools at high speeds by employing existing cable and phone lines. Further, small satellite dishes using Direct Broadcast Satellite (DBS) technology can be used by schools to receive internet data-transmissions in addition to audio-visual programming. Schools can sign-on to internet service providers and access the internet via slow-speed modems.

This project seeks not only to provide schools with access to the internet, but also to allow teachers and students to produce and generate their own products, serving and sharing them with a world-wide audience. While receiving internet information is not a problem, allowing schools to serve their own materials to the internet is more difficult. Depending on cable access, proximity to universities, topography, and a variety of other factors, different classes of solutions can be enacted to give schools both in and out internet connections. For instance, urban schools with cable or fiber connections can both access and serve internet resources at low-cost. Urban schools and rural schools without these connections, however, must rely on other solutions such as microwave technology to both access and serve internet resources.

Clark-Atlanta, Inner-City Technology Model

The technology design team at the Georgia Center for Advanced Telecommunications Technology originally planned to make use of the existing infrastructure at Washington High School (i.e., reverse path coaxial cable) to establish an internet link downstream from Clark-Atlanta University and upstream from Washington High School. However, cable companies providing service to the Washington High School area are not offering two-way internet service at this time. They are in a transitional phase, planning for future services, so the original plan to use cable reverse path technology did not fit within the time frame of this project. Current plans are to establish a microwave connection between Clark-Atlanta University and the high school as outlined below.

University of Georgia, Rural Technology Model

Without an existing infrastructure of cable wiring, the rural Oglethorpe Middle School technology model involves a wireless microwave link between a communications tower near the school and the University of Georgia. The school currently uses dial-in modems to reach the internet at a speed of .25 megabits per second. The microwave link will speed up the rate at which students can access and download resources by 8 to 16 times–2 to 4 megabits per second. An Aironet 2Mbps long range wireless ethernet bridge has been purchased and will be placed atop the University of Georgia library. This will convert data signals from the library's network into microwave signals that are sent over a 21dBi solid dish antenna to the communications tower near Oglethorpe Middle School. Another solid dish antenna and ethernet bridge will reside on that tower to receive and decode the microwave signals. To get this signal into the school, two options are being considered. First, hard wiring a short line between the tower and school are possible using either 10 Base 2 coaxial cable or 10 Base T twisted pair cable, depending on the school's current intranet network configuration. 10 Base 2 is easier to install but can lead to internal troubles (e.g., if one person disconnects from the network, occasionally the entire network can go off-line). 10 Base T involves wiring each computer separately from the school network hub, however troubleshooting becomes much easier when one computer goes down. The second option for transmitting the data signal from the tower to the school is to purchase two additional dishes to establish a wireless hop.

Why Use Wireless?

The disadvantages of using wireless signal transmission include: it is more costly to install than a T-1 line in terms of equipment; establishing the necessary line of sight may entail placing equipment on towers or tall buildings; weather conditions can slow data rate transfer; and the farther the school is from the originating site, the more the data signal is degraded. These are properties of the Aironet long range wireless ethernet bridge being purchased for the Oglethorpe Middle School connection.

Advantages of using wireless transmission include: schools avoid costly monthly fees to internet service providers, thus the system is more cost-effective than T-1 lines over time; the system is controlled by educational institutions, not an external agency or company (i.e., cable company); and, there is no need to wire an infrastructure, dig trenches, lay fiber or co/ax cable, or obtain public right-of-way. Monthly service fees for schools opting to install a T-1 line currently range from $600 to $2000 per month. Rural areas can expect to pay higher fees. Installation costs for a T-1 may run near $2000. The in-house wireless system for Oglethorpe Middle School has been purchased for a one-time fee of $12,000, with the understanding that the school will get internet access for free through the University of Georgia, a communications company near the school will provide free space on its tower to establish direct line-of-sight requirements, and installation of the system will be free to parties involved through the Georgia Center for Advanced Telecommunications Technology (GCATT). Through collaboration, a relatively low-cost solution has been afforded to one school which may serve as a model for future state efforts at wiring other schools, particularly in rural areas.

Home Access

Establishing internet access for students at home is considered a key component of this project. Once again, the goal is to test low-cost solutions that can be enacted on a state and local level rather than experimenting with high-cost, state-of-the-art technologies. Cable television companies typically set up many cable head ends around large cities and smaller markets–examples include airport channels and community access channels. For this project, a no-cost agreement has been reached between local cable companies and the public schools to turn school video studios into a cable head end. Once again, line-of-sight microwave signals will be used and will be transmitted via a satellite dish from the school to the cable company. The cable company will broadcast student video programs and/or internet signals over a community access channel at agreed upon times. This creates a downstream link from the internet into students' and teachers' homes. To make all of this happen, students and teachers at home will utilize a GCATT device known as the "telemouse" to communicate computer commands back to the internet browser located at the school. The current version of the telemouse includes a keyboard and mouse which plug into a modulating box. Students dial in to a school telephone line which connects their telemouse to an internet-ready computer. As students search web pages, the video signal is transmitted to the cable company which comes into students' homes over standard cable wiring. The cost of each telemouse device is approximately $50, priced comparatively near a library book. Students at each school will likely check out and be responsible for this equipment during the term in which their classes utilize the internet. Two concerns emerge from this model. First, only one student at a time can access the internet from home, and these interactions can be viewed by anyone with access to that cable channel. Second, although cable penetration is quite high, there may be some students without cable tv who will be denied the benefits of home access.

Those involved with the project are already considering new models of instruction that this system may afford. By placing certain groupware programs on the school computer transmitting signals to the community, it is possible for a teacher to get on-line from home and send his or her voice and image over the cable system to students and parents at home. Groupware products will not only allow an individual to be seen and heard, but will also allow students to work on written documents together, or to demonstrate their work to an extended audience. The enhanced techniques and increased reach truly define one model for moving the school from "behind closed doors" into the community at large.

Resource Sharing

Programming time on cable tv, equipment, and physical space on a communication tower are examples of free services and technology being offered by local businesses to sustain a low-cost model of internet access for this project. Businesses across the state (e.g., cellular, cable, network tv) see this sharing of resources as a profitable approach as they usually must pay for land to put up towers. In the future, schools might lease property to these businesses for free in exchange for space on their towers. Experimenting with connectivity possibilities at test sites should help inform the feasibility of new approaches like microwave technology for the schools and internet access equipment for students at home.

Increased Support for Contemporary Models of Learning

Providing public schools with access to technological resources is an important step, but there is still a need to consider pedagogical issues, instructional design, and the eventual manipulation of these resources. Just as a set of encyclopedias has never been a curriculum, a low-cost internet connection will not instantly revitalize public education. By developing a technical infrastructure for our public schools, however, we are enabling teachers with technology and access to resources which will support contemporary models of learning. These new models often establish learning environments or dynamic systems where students learn through experience rather than compliance, manipulate rather than memorize, and hypothesize rather than tacitly accept.

The capacity to set up problem-based learning environments via the internet is encouraged through this project. Internet environments with a problem-based focus afford several benefits over traditional instructional methods in teaching science, including:

1) establishing support for discussion among students and instructors through synchronous communication,
2) creating a mechanism for accessing new information and external resources,
3) providing a mechanism for collaboration on products and/or shared work space,
4) developing a mechanism or strategies to provide experiential opportunities for the learners, and,
5) creating a mechanism to provide training and mentoring.

A goal of this project is to move students toward scientific literacy. We suggest a number of measures here which will support students in the investigative or scientific reasoning process as they work in technologically-enhanced schools. These stages emanate from the problem-based learning process as defined by [Barrows 1995] as well as the network science model outlined by [Feldman & McWilliams 1995] at TERC. Overall features include:

1) group communications: students can post to a group, other individuals, or a classroom facilitator via e-mail; and, real-time conferencing is possible as needs arise during resolution of scientific problems;
2) links to internet resources, multimedia databases, and other authentic information sources used in gathering and analyzing information during scientific problem resolution;
3) on-line simulations or games that introduce problems and guide students through the investigative process;
4) examples of completed problems or documents by previous students who have resolved a problem
5) the presentation of problems that contain less scaffolding for the students and require them to facilitate problem resolution; and,
6) document creating and sharing.

Science Education, Curriculum Planning

Science education is at a critical point. It is becoming explicitly more evident for all people to become science literate. As citizens are being required to make decisions on environmental issues, consumer products, etc., it is important that they have an understanding of the process of science and its impact on society. Only 20% of the

U.S. population has the knowledge to be considered scientifically literate [Gallagher, Stepien, Sher & Workman 1995]. It has also been determined in a study by [Miller 1989] that pre-college learning does not contribute significantly to developing scientific literacy.

Scientific literacy as defined in this project is an awareness of the problem solving process including the abilities to make qualitative judgments about what science offers to society and the perspectives from which it comes. Currently K-12 science curricula are based on a foundation of established facts. This does not model what occurs in the question-centered, collaborative practice of scientists [CoVis 1995]. There is an increased need to move science education toward obtaining proficiency in the scientific, problem-solving process, and this project is exploring how innovations in technology and pedagogy can be used to meet the needs of today's pre-college science literacy curricula.

Scientists at The University of Georgia and Clark-Atlanta University have volunteered their time to work with teachers on this collaborative project. Together, they are discussing appropriate design and implementation measures and are developing problem-based curriculum plans that will make use of the new technological infrastructure. Such partnerships between the "ivory tower" and the school "trenches" allow university researchers to study novel approaches to teaching and learning while assisting teachers with their questions and concerns as they attempt to integrate technology in the classroom.

Some of the questions under consideration by the teacher-researcher collaborative teams include: what strategies and technological features will enable problem-based learning environments, how do teachers and students communicate in problem-solving activities, and what types of communication and/or activities might be best delivered in a distributed environment that includes the home?

One scientist, [Hagen 1996], describes his vision of the curriculum:

> I envision teachers, students, and parents using the tools we are creating for the AT&T project in a location and time independent fashion as needed to complete their class projects. I would like the classroom to be like a short business or research group meeting with teachers and students then spending most of their time working on their respective projects. I envision our support tools being on a server. It would serve the tools and their content, rich data sets for student projects, connections to specialized research instruments or software, have links to relevant on-line information resources, and communication/collaboration tools. I see teachers interacting with each other, students, parents, and outside experts and also students interacting with each other, teachers, parents, and outside experts. Some but not all of this could be on an in-school server, but it would be much better to have robust connections beyond the school to homes, libraries, universities, etc.

Two instructors working with the project have chosen to modify an existing lesson plan to meet both state and local curriculum requirements as well as goals of the project. The lesson "Consumer Fair" encourages students to develop process skills as they design experiments which test products. The main purpose is to help students understand the variables involved in designing scientific experiments and to use the scientific method in carrying out those experiments. Students are to bring in low-cost materials from home to conduct their experiments. They may ask such questions as, "which diaper holds the most water," or "which popcorn pops the best?" Teachers will assess students according to the background information they use to inform their hypotheses and questions, their creativity in experimental design and presentation, and their organization and clarity of argumentation when reporting overall findings. The internet connection will assist students in gathering information, communicating with experts, and eventually publishing those results in the form of web pages. To maximize their short class time, teachers will not allow students to randomly browse the internet during regularly scheduled school hours. While some gathering of information may take place in the classroom, most class time will be reserved for discussion, experimentation, and development of final reports in the form of web pages. Once students select a topic, they will be able to conduct background research and gather information from the internet at home using the telemouse equipment. Teachers will also be involved in gathering resources for students, using their home access equipment.

Future Plans

An evaluation plan is being developed for teachers and researchers involved with the project to collect information. The focus will be on the influence of the developed infrastructure as well as the applied problem-based curriculum during a two-week demonstration period in May, 1997. Updates and results on "Science Connections: Problem Solving at a Distance" can be obtained at the following World Wide Web site: http://lpsl.coe.uga.edu/projects.html. Finally, with the technical infrastructure in place, these schools will serve as test beds for future collaborative research efforts between teachers and university researchers.

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Evaluating the Quality of Internet Information Sources

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Abstract: Internet information sources are proliferating at an astonishing rate, however much of that information is of dubious or unknown quality. Educators are in need of instruments to assist in evaluating information quality, which is the goal of a project underway at The University of Georgia. Indicators of information and web site quality have been identified, classified within eleven criterion categories, and rated in terms of importance by a panel of experts on Internet resources. The highest rated indicators of information quality will provide the framework for a set of instruments and procedures for the evaluation of Internet information resources. Along with the information quality indicators, highly rated indicators of site quality will be used to provide design guidelines for the developers of Internet information resources.

Introduction

Internet resources, in particular World Wide Web resources, continue to proliferate at an astonishing rate. A great deal of information is posted to the world every day, but unfortunately very little is of high quality. Unlike professional journals and commercial publishers, who employ a system of editorial review and external referees to ensure the caliber of materials distributed, information can be spread over the Internet by anyone without regard to accuracy, validity, or bias. Due to its global structure, which encompasses a variety of legal systems and cultures, it is unlikely any one individual or nation will be able to significantly influence, regulate, or change the chaotic state of flux that characterizes the World Wide Web. As indicated by a content analysis conducted by [Debashis 1995], much of the material posted on the Internet is self-promotional or commercial (21.9% public relations and 20.7% advertising).

The low quality level and the need to carefully evaluate electronic information has been alluded to by several authors [Descy 1997] [Fitzgerald 1997]. Some groups claim to be rating the "quality" of Internet information (e.g., Point Communications' Top 5% of the Web, and Magellan's Star Ratings Systems). Typically, these focus on such indicators of "quality" as how "fun" or "entertaining" a web site appears to be, rather than the instructional value or validity of the content within that site. A need exists for criteria and procedures that will assist students, teachers, and other users in evaluating the quality of Internet information and for standards to guide the design of web resources. This paper is a progress report on a project that was established to develop such a set of criteria and standards. The project is being conducted in six phases, as described below:

Phase One: Identification of Possible Criteria

Phase one dealt with the identification of possible criteria that could be used to evaluate the quality of Internet information. A number of sources were consulted to extract this information. Among these were (1) compilers of highly rated resource lists, (2) periodicals, journals, and published indexes dealing with Internet resources, (3) on-line rating services, and (4) authorities on library reference materials and processes.

The most valuable sources of information were compilers of Internet resource lists. Individuals or groups that actively maintain listings of Internet resources on a variety of topics (e.g. engineering, science education, cooking) were identified from the listing maintained by The University of Michigan's [Clearinghouse for Subject-Oriented Internet Resource Guides 1996], now the Argus Clearinghouse, which evaluates Internet resource lists. The compilers of lists, which were given high marks for resource evaluation by the Clearinghouse and which were being actively maintained, were contacted via e-mail and asked to describe the criteria they used for selecting resources. Of 43 compilers contacted, 36 responded to the e-mail, and 24 provided selection criteria. A total of 147 suggested criteria or quality indicators were provided by the list compilers.

To identify further criteria of information quality, we consulted a variety of periodicals, journals, and published indices that suggested or rated Internet resources, including *Wired*, *NetGuide*, *The Internet Yellow Pages*, and *The Net*. In addition, the web sites of on-line rating services that provided evaluations of Internet sites were consulted. Typically, these publications and groups did not list selection criteria for the resources they chose to highlight. Those that stated any criteria at all typically focused on vague characteristics of resources such as "well executed," "hip," or "innovative." Such criteria have little to do with the information quality of a resource. Criteria such as "purpose," "coverage," "currency," and "accuracy" are better suited to select and recommend Internet resources. Such criteria provide a standard by which to measure the information quality of an Internet resource. Criteria of this type were more commonly located within the literature on library reference source evaluation [Katz 1992] [Bopp & Smith 1991] and the literature on instructional/web site design than from popular press Internet magazines and on-line rating services. Using such sources, an additional 362 items were identified to produce a total listing of 509 possible criteria or indicators of quality.

Phase Two: Editing and Consolidation of Criteria

Phase two dealt with the editing and consolidation of criteria. A content analysis was conducted on the 509 original items to eliminate duplicate items and clarify those with ambiguous meaning. Any items that were meaningless or which could not be operationally defined, such as "I pick the good stuff," were eliminated. Through this process, the original listing was reduced to a total of 125 indicators of resource quality. The 125 indicators were categorized under eleven major criteria. The major criteria along with the number of indicators within each of the criteria categories are listed below in Table One. Definitions of the criteria as well as a complete listing of the 125 indicators of quality have been published in the May/June, 1997, issue of *Educational Technology* [Wilkinson, Bennett & Oliver 1997].

Phase Three: Evaluation of Consolidated Criteria

Some of the indicators identified in phase two seemed to deal more with aspects of the web site than with the quality of the information provided by the web site. Also, 125 indicators were too many to be of practical use by resource evaluators. Therefore, phase three of the project sought to use the opinions of experienced Internet resource users to identify the focus and assign a rating of importance to each of the indicators. Of the 36 compilers of highly rated resource lists responding to our call for evaluation criteria, 30 had agreed to serve on a panel to rate the criteria that were developed. Since the Argus Clearinghouse continually evaluates lists and adds new resource lists to its on-line database, we were able to identify an additional 61 compilers of Internet resource lists that were highly rated on resource evaluation. These individuals, along with 13 compilers who had not responded to the initial invitation, were invited to join the review panel for phase three of the project. Of these, 34 agreed to join the panel, creating a total of 64 compilers who agreed to review the list of quality indicators.

A questionnaire was developed that asked panel members to identify whether each of the 125 items was an indicator of information quality, an indicator of web site quality, or an indicator of both and to rate the importance of each criteria on a six point scale ranging from irrelevant (1) to essential (6). The panel was also encouraged to provide comments and suggestions related to the criteria categories as well as the individual indicators. To collect this information, two versions of the questionnaire were created--one web-based and the other on paper. Copies of these instruments are available for examination through the project's web site [Wilkinson, Oliver & Bennett 1997]. 34 of the panel members were mailed paper copies of the questionnaire along with pre-paid return envelopes and the remaining 30 members were mailed letters inviting them to link onto the web-based questionnaire. One month after the initial mailing, the panel members who had not responded were contacted by e-mail and offered the alternative versions of the questionnaire.

Of the 64 panel members who had agreed to participate in phase three, 49 completed the questionnaire for an overall return rate of 76.56%. 28 paper questionnaires (82.35%) were completed and returned while 21 panel members (69.9%) completed the web-based questionnaire. The lower return rate for the web-based questionnaire, despite the perceived ease of using such forms and the Internet access and familiarity of the panel members is an interesting question for further research. Demographics of the responding panel members include the following: 75% male, 25% female; equally dispersed in age from 18-58; 73% work within higher education, 13% in business/industry, with just a few in government or k-12 school setting; and 40% were specialists in the library and information science field, 36% in an academic subject field, and 13.3% came from computer science/technology.

Although each of the indicators was felt to deal with some aspect of the quality of the Internet resources that were located, some of them dealt with the information while others appeared to deal more with the quality of the site or the experience of using the site. Responses to the first question following each indicator were used to classify the indicator as dealing primarily with the site, the information within the site, or with both site and information. If fifty percent or more of the panelists indicated that the item either dealt with site or with both site and information, it was classified as an indicator of site quality. If a similar percentage felt the item dealt with information or both site and information, it was classified as an indicator of information quality. As a result, a total of 45 of the 125 indicators were categorized as dealing with both site and information quality. The other 80 indicators were divided between site and information to produce the distribution within criterion categories as shown in Table One below. As can be seen in Table One, a few of the criteria categories, such as "Site Access and Usability" and "Aesthetic and Affective Aspects," deal primarily with the quality of the web site while a number of the other criteria categories deal entirely with the quality of the information within the site.

	Number of Indicators		
	Total	**Site**	**Information**
Criterion 1: Site Access and Usability	18	18	2
Criterion 2: Resource Identification and Documentation	13	4	13
Criterion 3: Author Identification	9	3	9
Criterion 4: Authority of Author	5	–	5
Criterion 5: Information Structure and Design	19	13	19
Criterion 6: Relevance and Scope of Content	6	–	6
Criterion 7: Validity of Content	9	–	9
Criterion 8: Accuracy and Balance of Content	8	–	8
Criterion 9: Navigation within Document	12	12	8
Criterion 10: Quality of the Links	13	10	12
Criterion 11: Aesthetic and Affective Aspects	13	13	6
TOTAL	**125**	**73**	**97**

Table 1. Classification of Indicators by Criterion Category

In addition to indicating the focus of each of the quality indicators, the panelists were asked to rate the importance of the indicator on a six point scale so that the more important items could be identified for inclusion in the evaluation instruments. Because individuals might be ranking items differently depending on whether they were thinking of the item as dealing with the site or with the information within the site, a mean value was computed for those who felt the item dealt with information quality and a different mean value was computed for those who felt the item dealt with site quality. The rank and mean value assigned to each indicator for information quality (those rated as important or essential) is presented in Table Two below. Values for site quality are presented in Table Three. The effects of classifying the indicators on the basis of the percentage of panelists who regard the item as dealing with site or information is born out by the fact that eight of the nine highest rated site indicators was dropped from the final list when the criteria was set at 50 percent for inclusion in the ranked listing. Using a 50 percent cut off, the total number of information quality indicators was 71 and total of site quality indicators was 67.

Rank	Mean	Indicator	
1	5.60	**9.1**	Is there a good organizational scheme (e.g., by subject, format, audience, chronology, geography, authors, etc.)?
2	5.37	**6.2**	Is the information sufficiently current to meet the user's needs?
3	5.35	**8.1**	Are there any obvious errors or misleading omissions in the document?
4	5.33	**10.10**	Are the links relevant and appropriate to the document?
5	5.32	**3.1**	What is the author's name?
6	5.29	**3.2**	What is the author's professional or institutional affiliation?
7	5.28	**8.5**	Does the author or the sponsor of the site have a vested or commercial interest in the topic?
8	5.27	**10.8**	Are the links evaluated in any way prior to inclusion?
9	5.19	**2.10**	When was the document last revised?
10	5.15	**2.1**	What is the title of the document?
11	5.09	**2.2**	Within what major fields, disciplines, or topics does the document fall?
12	5.07	**5.5**	Does the content fit the stated scope, purpose, and audience?
13	5.05	**6.1**	Is the content related to the user's needs?
14	5.03	**5.1**	Is the scope of the document clearly stated?
15	5.02	**4.1**	Is the author a recognized authority on the topic of the document?
16	5.00	**8.3**	If the document deals with controversial issues, is the bias of the author clearly identified?
	5.00	**7.6**	Does the author provide a bibliography or cite references to confirm the accuracy of the information?
18	4.97	**5.3**	Is the title of the document descriptive of its content?
19	4.93	**8.4**	Is the site sponsored or cosponsored by an individual or group that has an established position regarding the issues discussed in the document?
20	4.91	**2.5**	Is there a description of the document's content?
	4.91	**5.6**	Does the use of graphics and icons contribute to the clarity and usability of the information?
22	4.90	**2.3**	For what audience was the document designed?
23	4.89	**1.2**	What individual, group, or organization sponsors and/or maintains the site?
24	4.88	**2.4**	What is the mission, purpose, or scope of the document?
	4.88	**10.9**	What are the link selection criteria, if any?
26	4.85	**6.5**	Are there any obvious gaps or omissions in the coverage of the topic?
	4.85	**9.2**	Is there provision for topic narrowing via conventions such as menus that follow the organizational scheme?
	4.85	**5.4**	Does the content fit the stated scope, purpose, and audience?
29	4.82	**3.4**	What is the author's training or experience with the topic?
30	4.76	**8.7**	Is the information presented in the document of a consistent quality?
		6.3	Is the coverage of the topic sufficiently broad to meet the user's needs?
32	4.74	**4.5**	Is the author affiliated with an educational institution, research laboratory, governmental agency, or other reputable organization related to the topic of the document?
	4.74	**2.7**	When was the document created?
34	4.70	**3.9**	Was the development of the document funded or otherwise supported by an individual, group, or organization other than the identified author?
	4.70	**4.4**	Is the author's experience appropriate and related to the topic of the document?
	4.70	**7.7**	Does the author provide verifiable statistics to support conclusions?

Table 2. Highest Rated Indicators of Information Quality

BEST COPY AVAILABLE

Rank	Mean	Indicator	
1	5.60	**9.1**	Is there a good organizational scheme (e.g., by subject, format, audience, chronology, geography, authors, etc.)?
2	5.34	**11.9**	Is the design so complex that it detracts from the content?
3	5.22	**11.3**	Are readability and legibility guidelines followed (e.g., sufficient color and tone contrast between text and background, font size, doesn't use all caps, etc.)?
4	5.05	**10.1**	Are the links clearly visible and understandable?
5	4.97	**9.7**	Is there a consistent sense of context or understanding of position within the document at any given time?
6	4.94	**5.6**	Does the use of graphics and icons contribute to the clarity and usability of the information?
7	4.91	**2.13**	What is the URL of the document?
8	4.88	**10.13**	How reliable are the links (are there inactive links or references to sites that have moved)?
	4.88	**1.2**	What individual, group, or organization sponsors and/or maintains the site?
10	4.85	**1.12**	Is it a commercial site that requires payment for full access?
11	4.81	**9.5**	Is there a table of contents that can be used to navigate within the document?
12	4.80	**9.4**	Is there an index that can be used to navigate within the document?
13	4.79	**9.2**	Is there provision for topic narrowing via conventions such as menus that follow the organizational scheme?
	4.79	**10.2**	Do essential instructions appear before links and other interactive portions?
15	4.77	**2.12**	If the resource is to be removed, does the site state where it will be available?
16	4.75	**11.1**	Does the document follow accepted graphic design principles (e.g., balance, unity, proportion, simplicity, etc.)?
17	4.73	**1.13**	If commercial, is the price specified up-front?
	4.73	**1.1**	What is the name of the site?
19	4.72	**11.5**	Do the creative elements enhance the usability and appeal of the document?
20	4.68	**1.10**	Is it usually possible to reach the site, or is it frequently overloaded or shut down?
21	4.65	**1.17**	If involving confidential information, are interactions secured?
	4.65	**11.2**	Does the document follow accepted text design principles (e.g., appropriate use of headers, limited mix of type styles and sizes, etc.)?
23	4.64	**10.4**	Are links annotated?
24	4.63	**11.8**	Does the interface make use of consistent menu conventions from screen to screen (e.g., terminology, icons, positioning on page, etc.)?
25	4.58	**9.8**	If linking to another page, is there a way to get back to the home page?
	4.58	**10.5**	Are users informed of the type of file they are linking to (e.g., video, sound, etc.)?
27	4.56	**2.6**	Is the user informed of improper or controversial materials (e.g., adult language, sexually explicit material, gratuitous violence, etc.) within the document?
28	4.52	**5.8**	Does the site offer a variety of features in addition to delivering content (e.g., provides e-mail links for further information, downloads, ordering, discussion lists)?
29	4.50	**1.7**	Is the document source code free of bugs and breaks?
30	4.49	**9.9**	Is it easy to locate a particular page from any other page?

Table 3. Highest Rated Indicators of Site Quality

Phase Four: Development of Evaluation Instruments and Procedures

During the Spring of 1997, the information developed during phase three of the project will be used to develop products in two major areas:

(1) The quality indicators that received marks near "essential" and which were classified as related to information quality will be used as the framework for the development of instruments to evaluate the quality of resources

located on the Internet. At the same time, procedures and strategies for effective searching for resources and for the application of the evaluation instruments will be developed.

(2) The criteria that were identified by the panel as being related to site quality and which received high importance ratings will be used to develop a set of guidelines for the development of quality web sites. These guidelines will then be used to develop templates for web site design.

The development of the different products will of necessity require some cross matching of indicator categories. For example, in order to determine the bias of vested interest of sponsoring bodies (information quality items #8 and #23) it will be necessary to identify the sponsor of the site (an item in Criterion 1 that was classified as a site indicator). Also, the web site design guidelines will need to contain the indicators necessary to make judgments about the quality of the information.

Phase Five: Field Testing and Validation

During phase five, the resource evaluation instruments and procedures developed in phase four will undergo a formative evaluation process with a population of undergraduate pre-service teacher training classes at The University of Georgia. These future teachers are representative of young learners that have been underexposed to evaluation and selection processes--especially of the dynamic and varied content accessible through the Internet. They also represent the models for more naive, younger k-12 learners who will depend on them to select quality resources or to scaffold strategic steps in searching for and retrieving on-line information. The final versions of the instruments will then be used by graduate students to assess the quality of representative samples of Internet resources within various subject areas.

Phase Six: Dissemination of Products

Following validation, information about the instruments and procedures will be disseminated by means of journal articles and conference presentations. The actual instruments and procedures will be made available, at no charge, through the project web site at The University of Georgia: http://itech1.coe.uga.edu/Faculty/gwilkinson/ webeval.html. Until the instruments have completed field testing, this site will contain continuing updates on the progress of the project.

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Exploring Student Interactions in Collaborative World Wide Web Learning Environments

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Abstract: This paper describes a study in which a WWW learning environment was created using socio-constructivist instructional design principles. A qualitative research method was used to investigate the learning behaviours of classroom-based students in this instructional setting. In particular the study sought to investigate collaborative learner behaviours in settings where the instructional materials involved open-ended investigations and learner support by means of a printed guide. Observations of student behaviours provided little to confirm our contentions that such environments will create an instructional setting which encourages cooperation, reflection and articulation among students.

Introduction

There is growing interest in higher education about the use of the World Wide Web (WWW) as a learning tool. The WWW enables the development of powerful information sources to support learning and facilitates student-centred instruction [Becker & Dwyer 1994]. It supports and encourages exploration and inquiry, behaviours that are frequently associated with enhanced learning outcomes. However providing students with access to such meaningful content does not always guarantee learning. Contemporary learning theories indicate that learning is achieved through a process of knowledge construction [eg. Reeves 1993]. When a learner is confronted with new knowledge, the learner's intentions, previous experiences, and metacognitive strategies are all essential elements in determining what becomes of the knowledge. The effectiveness in any learning environment is based upon the types and levels of cognitive and metacognitive activity engendered in the learners. It is now widely accepted that learning is enhanced in instructional settings where students are engaged in processing personally relevant content and are reflective during the learning process [Jonassen 1994]. The use of collaborative learning environments seems a natural way to create such settings. This paper describes a study which was conducted to investigate the potential of a collaborative WWW-based learning environment.

Learning Through the WWW

There are a number of learning theories which can been used to describe the nature of learning in WWW and other multimedia environments. In our previous research we have been guided successfully by the theories of situated learning [Brown, Collins & Duguid 1989], social-cognition [Vygotsky 1978] and conversation [Laurillard 1995]. Such theories apply and extend information processing and constructivist learning ideas in ways which are well suited and potentially very powerful in higher education learning environments. Interest in social-cognitive theories and in social-constructivism has been fuelled in part by a growing awareness of weaknesses in information processing and constructivist approaches to describing learning [Prawat & Floden 1994]. Talk and discourse have long been seen as critical components of the learning process. [Vygotsky 1978] argues that learning is frequently achieved through interactions supported by talk and that language and talk are frequently associated with the development of higher order learning. Higher-order learning is achieved when students are confronted by tasks which lead them into cognitive conflict and resolution. Dialogue and discourse enables and encourages this form of cognitive activity by providing a context and means for explaining, justifying and acquiring reasoning skills.

The learning value of language and discourse is acknowledged as one of the main reasons for the popularity and instructional effectiveness of collaborative learning environments. Collaborative learning is consistently used by teachers in elementary and secondary schools and continually returns significant achievement gains. These gains are usually attributed to the complementary effects of motivational and cognitive factors. The motivating factors encourage students to work towards common goals in cohesive groups where the interests and achievements of all learners are important. The cognitive gains are derived from developmental perspectives associated with children's social interactions, and resulting cognitive restructuring and elaboration brought about by the discourse and dialogue [Damon 1984]. Currently much of the teaching and learning in higher education associated with computer-based delivery is planned for individuals learning independently with computers. There appear many advantages to be gained from a move to more collaborative and cooperative learning environments.

[Slavin 1996] describes a number of strategies which have been found to enhance and encourage cooperation and collaboration in small group settings. Some of the strategies described include: developing investigative and controversial tasks without single answers to encourage articulation, discussion, and debate among learners; creating group goals for learning tasks which promote collaboration and individual accountability; and providing strategies and support to promote and aid interactions between learners. [Pilkington & Parker-Jones 1996] suggest the need in collaborative environments for pairing students with symmetrical roles to encourage them to argue and to prompt reasoning. [Palincsar & Brown 1984] describe the valuable role of tutor scaffolding to help develop dialogue strategies, and the consequent withdrawal leaving learners to generate their own discourse.

There are many forms of supports for collaborative learning although in higher education, some appear to hold stronger prospects than others. Adult learners tend to show high levels of self regulation and self-motivation in their approach to learning. In group situations, the better supports appear to those which provide a context and method for collaboration. In this project we chose to investigate the potential of the use of investigative activities and scaffolding devices as instructional supports for collaborative WWW learning. Our intention was to examine the ways in which WWW materials with open-ended inquiry based activities and support materials supported and encouraged collaborative activities, and to examine the forms of interaction and collaboration that resulted to see if these attributes influenced students' levels of cognitive processing and engagement.

Methodology

We chose a module from a local course, Multimedia Networking and Communications, for this study. A lesson was planned for a component of the course where use of the WWW as an instructional tool would be most appropriate. A WWW-based document, *Designing Home Pages*, was developed which was intended to assist students to develop a knowledge and understanding of the use and design of home pages. We created a WWW-based instructional episode that incorporated the lesson content supported by a number of open-ended and inquiry-based activities. The document comprised four chapters, each of which contained a textual description of the topic, links to relevant sites, a learning activity and a series of quiz questions. Each chapter of the document contained approximately 500 -750 words of text, 20-30 images of sample home page designs and elements, and 15-20 links to relevant WWW documents and sites.

This study was part of a larger research project research conducted among 58 university students. The component involved six students, working in three pairs across three different laboratory sessions. The students completed their learning activity on a computer with special data gathering devices attached. A small camera above the computer was used to gain and audio and video record of student interactions and this image was recorded as a window on a larger image of the display from their computer. These images provided a video recording which enabled us to see how students were behaving, to listen to what they were saying and to view the screen images with which they were working. Transcriptions were made of the discussion and exchanges between the students in each of the three groups. The interactions and exchanges between the students were tabulated and classified.

In our previous studies of learner interactions in telecommunication supported learning environments [Oliver & McLoughlin in press], we have used a set of 4 dimensions developed from [Henri 1992], namely social, procedural, expository and cognitive. More recently [Pilkington & Parker-Jones 1996] describe the DISCOUNT analysis scheme for analysing learner dialogue in collaborative environments with 5 dimensions to record the purpose and forms of learner dialogue. While these dimensions are able to provide more detail of the purpose of interactions than those we have used previously, we chose to remain with our more general content analysis as a means to explore the general nature of student interactions in the planned environment. Our intention in this initial study was to determine the capacity of the chosen interventions to promote dialogue and discourse through collaborative learning. Our investigation sought to establish the forms of dialogue that resulted to determine if students' levels of cognitive activity and engagement were influenced. The dimensions used in this study are explained in [Tab. 1].

Type of Interaction	Description	Example
social	students discussing elements of a social nature and not directly associated with the lesson	S1: What course are you studying? S2: Multimedia and communications. S1: Does that mean you know my friend John?
procedural	students discussing matters relating to procedures and steps associated with the learning materials and WWW browser	S1: What do we need to do here? S2: I think we should go to the first screen and read the instructions. S1: Okay, I think you click here to do that.
expository	exchanges where facts and knowledge are passed with little further elaboration or development through discussion, articulation of information	S1: The screen design here is quite good. S2: I like the colour and the images. S1: The text is well laid out and easy to read. S2: The format is a bit wide.
cognitive	students' discussion leads to knowledge development and involve exchanges which demonstrate critical thinking and reflection	S1: Is this Home Page better than the previous ? S2: It's much clearer and more spacious. S1: I think the space makes the page less cluttered and the picture is less busy. S2: The space also make the links more apparent.

Table 1: A framework for describing interactions in collaborative learning environments

Outcomes

Group 1: Chris and Kate

This pair of students comprised both an experienced and inexperienced WWW user. The pair used the printed guide which provided instructions and directions in how the WWW document should be used. Initially a large number of procedural interactions were observed as the pair decided the format and scope of the task they had been set and explored the WWW environment. The more experienced user, Chris, assumed control of the mouse and maintained this for the whole of the session. Kate had had some experience with the WWW and appeared quite comfortable with the navigation and linking processes employed by her partner.

As the pair settled into the exercise, they adopted a style of displaying the screen information and each reading it quietly to themselves. This left many periods in the observation where no discussion or exchange was taking place. While other students often used such opportunities to discuss and articulate the information, this pair displayed a tendency to work independently and maintained this throughout the session. Chris would wait until Kate had appeared to have finished reading before moving to link to other pages and sites. There was rarely any discussion about which site would be chosen. Kate appeared content to let Chris choose. When pages appeared, Chris would often make a comment, for example, " nice graphics" and "I wonder what this means?". Mostly Kate would say nothing and Chris would choose another site and browse again. There were many examples of expository interactions evident in these stages that involved very short and abrupt information exchanges.

The printed guide contained a copy of the activities from the WWW document and provided space for written responses. It was intended that the students would read the textual information in each WWW chapter and attempt the activity once they had developed some understanding of the current chapter. This pair of students tended to commence the activity as soon as they moved to each new chapter. Once again, this was done independently and there were several minutes of silence as the pair made their own notes. On several occasions, Chris commented aloud as he wrote things down and Kate concurred, but the discussion rarely developed further. This limited form of collaboration gave rise to a large number of very short expository interactions, the majority of which were initiated by Chris. In many instances Kate's contribution was agreement with no further elaboration. This form of communication limited the scope for cognitive interactions.

The last chapter in the document provided links to Home Pages of movie companies and when these sites appeared, the conversation became more discursive. Both students were interested in movies and immediately began discussing aspects of the movies that were displayed on the screen. These interactions were clearly social in nature and bore little relevance to the design aspects which were meant to be leading the conversation. [Tab. 2] shows the number of the different types of interactions observed between these students. The table shows a relatively small number of interactions in the 80 minute session and the absence of any cognitive interactions.

Type of interaction	Frequency	Relative Times
social	5	10%
procedural	15	38%
expository	31	52%
cognitive	0	0

Table 2: Interactions observed between Kate and Chris

The lack of cognitive interactions among these students was unexpected. While there appeared to be many opportunities in the learning materials for the students to reflect on issues and to discuss ideas and findings, they did none of this. The pair were clearly mismatched for this type of learning activity. At the same time, it appeared that the form of the printed guide also acted as an impediment to the collaborative activity. In following the guide, both students made their own meaning of the content that was presented and created independent accounts in their notes. The guide did not specifically encourage students to work collaboratively and in this instance, they chose not to. In providing a focus for student learning, the guide encouraged the students to follow the lesson content in a structured sequence and this limited the level of cooperation and collaboration that was observed. It is likely that had the guide carried less explicit instructions, higher levels of collaboration may have occurred.

Group 2: Raelene and Alan

This group also comprised a novice and experienced WWW user. This pair worked without the printed guide and followed their own path through the WWW pages. In the first stages of the session, there were a number of procedural interactions caused by Alan explaining different features of the browser and the pages they were downloading. Raelene was content to let her partner take the lead in deciding which links to take and when to proceed. There was a number of expository interactions as Raelene inquired further from Alan about the sites they were visiting and the content of the pages displayed. The lack of direction, from the printed guide, for example, encouraged collaborative interactions by virtue of the need for the students to agree on a learning strategy. This pair spent considerable time on the first two chapters but there was little evidence of any purpose or focus in their activity. Alan concentrated on the textual components of the chapters and followed the links that were provided going from one to the next with no apparent aim in mind. During this browsing, there were many expository interactions and few cognitive interactions. The pair viewed the pages that appeared and commented to each other on different aspects of the pages.

The pair attempted none of the activities but spent considerable time working through the quiz questions. The use of a printed guide may have ensured that the activities were attempted and could have led to the students' attention to more meaningful information and content. It was in reading and answering the quiz questions that most of the cognitive interactions occurred. The pair discussed the solutions to the questions and often built on each other's responses. The open-ended nature of many of the questions encouraged this reflection and critical thinking and the contributions of each partner often led to creative and joint solutions being developed. The nature of the discussion and exchanges between these two students tended to change as the lesson progressed. There were many interactions of a procedural nature at the start as Alan explained features to Raelene. The level of procedural interactions may have been different had Raelene had more WWW experience.

Type of interaction	Frequency	Relative Time
social	2	2%
procedural	32	32%
expository	28	41%
cognitive	13	25%

Table 3: Interactions observed between Alan and Raelene

[Tab. 3] shows the relative numbers of interactions observed among these students and the relative proportion of time of each. Both the design of the learning materials and the nature of the learning environment had led us to expect that there would have been a higher level of cognitive interactions than which actually occurred. Factors which appeared to limit the number of such interactions in this instance included the pairing of a novice and experienced user, the high level of browsing, students' choice not to undertake the activities and the failure of the students to establish an appropriate pace to cover the contents of the WWW document in the given time.

Group 3 Danni and Vicki

The third pair of students were friends. This pair also did not have the printed guide and were free to use the materials in their own way. Observation of their behaviours clearly indicated the value of cooperating partners. The pair chatted freely throughout the lesson and shared the *driving* equally. The high levels of cooperation saw a large number of short procedural interactions interspersed throughout the session as each indicated the next step that might be taken and waited for any dissenting or alternative suggestion. In most instances, a statement of the form, "let's go here" and a pointing action to a link on the screen led to that action being taken. Often the student without the mouse made the suggestion as to the next site to visit or link to make, and the other effected the action. In this group, the student with the mouse did not lead but rather acted as the agent who carried out the next step according to her own or the other partner's wishes. The mouse was swapped frequently. Both students interacted freely and large numbers of exchanges were recorded [Tab. 4]. While there were many procedural interactions, the brevity of the exchanges reduced the relative time of these. At the same time, there were few cognitive interactions overall but the level of discussion involved for each saw an appreciable amount of time in the session spent in this form of interaction.

Type of interaction	Frequency	Relative Times
social	1	1%
procedural	34	23%
expository	45	60%
cognitive	6	16%

Table 4: Interactions observed between Danni and Vicki

This pair followed the WWW document sequentially and attended to each component in turn. As the students worked through each activity, there was a large amount of discussion and articulation of the content that was being presented and a considerable amount of important information was discovered and gleaned by the students in this way. The textual information contained in the body of each WWW chapter served to reinforce the students' learning but the links in the body of the chapters appeared to be distracting. We found ourselves wondering about the value of these links. They encouraged browsing and unstructured investigation while those in the activities formed part of a planned inquiry. There were a few occasions during the session when the interactions were cognitive in nature.

Summary and Conclusion

Observations of student behaviours did not provide confirmation of our contention that the planned environments would encourage cooperation, reflection and articulation among students. The use of the collaborative setting was expected to yield a far higher amount of cognitive interaction between the learners. There were a number unexpected outcomes relating to the influence of the printed guide and the investigative activities on the extent and forms of the interactions observed. In all groups, there were considerably more procedural interactions than anticipated. In some cases, this was brought about by student uncertainty in the unfamiliar environment, elsewhere it was brought about by students establishing working patterns. It was clear to us after observing the students that any new learning environment would likely reflect this outcome. We would expect if these students attempted other WWW activities now, there would likely be less of these interactions. However the procedural interactions associated with cooperating behaviour would still remain.

Expository interactions often involve articulation and tend to reflect lower levels of cognitive engagement but they help to build understanding by the passage of information and content between learners. In ideal circumstances, expository interactions can and should initiate cognitive interactions. There were many instances in this study where students exchanged ideas and views that could have led to higher-order thinking and exchanges but didn't. Often this was as a result of one student failing to attend to what the other was saying and not extending the item under discussion. Even the most cooperative students tended at times not to listen to what their partners were saying. One factor contributing to this appeared to be the lack of learning goals. The activities did not require students to derive any particular or agreed outcome. Also, the large amounts of textual information and links appeared to distract students, encouraging browsing and unstructured inquiry.

We felt that the principal reasons why there were fewer cognitive interactions than expected and why the number and forms of interactions varied within the different groups were attributable mainly to: group composition, inappropriate composition of groups can lead to non-collaborative environments; lack of instructional support, in instances where students are not guided by instructional support, they can choose to follow paths of their own choosing and avoid activities which the instructor may wish them to complete; inappropriate information display, it does not appear appropriate to use large amounts of text and investigative activities in WWW pages; inappropriate design for collaborative learning activities, in collaborative settings, activities need to be designed specifically with collaborative components and suggested roles for group members that encourage discussion and articulation; lack of learning goals, the students were not guided by any particular goals or stated outcomes; and distracting elements, the inclusion of links and examples in textual and content related sections of WWW materials can distract some learners from the information being presented;

To gain maximum advantage from the collaborative and investigative environment, we suspect that more ideal forms of implementation are those where: group composition is more carefully planned; where students are required to provide feedback of some form on their outcomes as an inducement to maintain focus and complete activities; and where this form of learning exercise is introduced after students have become more familiar with the WWW; and where more adaptive forms of scaffolding providing selective assistance are employed, for example, through an instructor or context sensitive help in the programmed materials. We intend now to revise our instructional materials to accommodate the changes suggested above and to repeat the study. We will look to see whether the changes are associated with increased levels of student collaboration, reflection and articulation and increased levels of cognitive interactions.

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Training Teachers for Rural and Distant Education: Using Authentic and Meaningful Contexts

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Abstract: This paper describes a project in Western Australia in which teacher-education students needing to learn practical skills of, and a theoretical understanding about, audiographics as an instructional technology, did so in a course where the technology itself was used as the delivery medium. This method of course delivery was characterised by a teaching program which involved such instructional attributes as: knowledge construction; authentic contexts; student-centred learning and collaboration. An evaluation of the course demonstrated high levels of student performance and satisfaction and positive learning outcomes.

Introduction

Many times in university courses, students are required to develop a defined set of skills and knowledge for application at some later stage in their careers and vocations. Teachers, for example, are often given formal courses in computers and technology to enable them to apply these technologies in their future teaching. These courses often take the form of lectures, demonstrations and practical classes. Research clearly shows that a person's ability to apply skills and knowledge is very much dependent on the way they learned them. Formal courses of instruction in teacher education as described above have frequently been found to limit understanding and future application especially in instances where technology and technological applications are concerned [see Robinson 1993]; [Downes 1993].

Consider our dilemma in teaching a pre-service teacher education course, Rural Education, at Edith Cowan University in Western Australia. This course aims to prepare students for, teaching in rural schools and teaching at a distance. Young teachers in rural schools are exposed to a range of difficult situations not encountered by their city counterparts. The geographical and social isolation resulting from being posted to a remote rural setting creates many difficulties as they strive to establish their competence and confidence in teaching. They are professionally isolated from the wide range of expertise and experience to which they have been accustomed and have restricted access to guidance and support systems. For these students to be successful in their rural schools they also need to have learned and developed self-sufficiency in the use and application of instructional technologies, confidence and ability to sustain technology skills through self-teaching, and skills in locating and accessing appropriate information and resources for rural teaching.

Audiographics Technologies

A standard instructional technology used for delivering educational programs within rural schools in Western Australia is audiographics. Audiographics describes a process where teachers and students at remote sites are linked through two main channels: an audioconferencing channel providing real-time oral communication and a computer channel providing a shared and interactive computer display. Audiographics is a powerful instructional medium for rural schools. Its application in WA has increased curriculum offerings to rural students with such instructional advantages as attitudinal and motivational gains and cognitive improvements [Oliver & Reeves 1994]; [McLoughlin & Oliver 1995]; [Oliver & Reeves 1996].

Since learning to teach with audiographics was already a component of the course, we designed an instructional approach that made use of the audiographics technology as a delivery system. This technology provided us with a demonstrated and strong instructional support for our teaching and also an environment where we could develop students' skills with telecommunications technologies. Applying the technology in this fashion seemed to provide a learning environment that would be meaningful and effective [e.g. Diem 1989]; [Novak & Knowles 1991]. Through the integrated nature of the instruction, it was anticipated that students would develop transferable and generalisable skills and knowledge that would be applicable in future settings [e.g. Prawat 1992]; [Rovegno 1993]. At the same time, by designing an on-campus course that used the best attributes of distance education, we hoped to also provide a setting to develop students' skills and abilities as independent learners and strong supporters of distance education as an instructional process.

The Program Design

The fundamental factor behind the design of the new course was the premise that learning environments that support knowledge construction and contextual learning are more effective and more successful than those that support knowledge transmission alone [Reeves 1993]. Learners receive knowledge from environmental stimuli and learning depends on how that knowledge is used. Information is coded and learned according to the meaning ascribed by the learner [Piaget 1954]. It was our intention that by providing an environment in which students learned through the medium of audiographics, they would construct a meaningful and relevant knowledge base of this technology and its use as an instructional tool. We wished the students to become active learners who would process lesson content through experiential and meaningful learning activities.

Another aim of the project was to create a student-centred learning environment that facilitated high levels of learner control. In rural settings, both students and teachers are often required to assume control and take responsibility of their own learning programs. In settings where the teacher assumes a facilitative and coaching role, students become active in the learning process. Rather than attending to a teacher-student dialogue, students can be working in a more autonomous role either individually or among themselves. Our project had two reasons for giving students much more control and personal autonomy in their learning. In the first instance they would likely benefit from this in terms of knowledge development. In the second instance, it would enable them to experience first-hand the forms of learning environments often experienced by distant students, giving these new teachers a realistic set of expectations and impressions of such instructional settings.

Perhaps the aspect of our project with the strongest potential for enhanced learning outcomes was its practical and authentic context. There is significant support in the literature for the benefits of contextual learning where students are taught and learn in environments that closely match reality. A major criticism of much of our current dominant pedagogical schemes is that they are too abstract, removed as they are from 'real world' experience [Brown Collins & Duguid 1989]. If knowledge, skills, and attitudes are learned in a context of use, they are more able to be applied and used in that and similar contexts.

Student behaviours that often have a significant impact on performance and learning are those brought about through collaborative and cooperative activities with peers [e.g. Slavin 1995]; [Herrington & Oliver 1996]. We sensed that there were strong benefits to be derived from our course if we encouraged peer collaboration. Apart from the increased understanding brought about through talk, the collaboration could provide support and coaching for the students in the absence of ready access to help from the instructor. Socio-learning theories such as situated learning highlight the place of coaching and scaffolding as integral components of effective learning environments [Collins Brown & Newman 1989]. In our course where instructor support was to be limited, the need for peer-support was seen as a critical element. At the same time, by experiencing first-hand the benefits of collaborative learning, the students would be likely to apply this strategy in their own teaching.

The Audiographics Course

With these ideas and principles in mind, a curriculum was developed for audiographics delivery in the form of modules with supporting materials. The curriculum was planned to be implemented in a virtual classroom with small groups of students in various locations across the university campuses linked through audiographics technologies. The audiographics links were designed across a series of lessons to provide instruction in appropriate parts of the course and to guide and direct students in their independent use of the supporting learning materials. It was planned that students would receive instruction and direction through attendance in audiographics sessions and would then independently and collaboratively complete a series of prescribed tasks and activities.

The content of the course required students to learn how to operate and apply: the hardware associated with telecommunications and audiographics; the mechanisms and processes by which the telecommunications and audiographics technologies operate, the skills required to independently use computers; telecommunications, audiographics and appropriate software; and the instructional skills and relevant pedagogy associated with teaching and learning with audiographics and telecommunications in rural schools.

Because this course was to be delivered in an external form, a range of learning materials was developed to form the basis of the independent student activity. The materials that were prepared and compiled included: a course guide, a booklet detailing the course, the time frame, the modules and instructional episodes and the activities and tasks to be completed; a set of readings describing the technology, its application and implementations; video materials showing examples of actual audiographics teaching and learning; instruction manuals and guides for the audiographics equipment and resources; a CD-ROM with materials to assist audiographics lesson planning; instruction manuals and activities for the Macintosh computer system; instructional materials describing the use of the audiographics software, Electronic Classroom [Crago 1992]; and an electronic document on the World Wide Web describing distance and rural education technologies and their applications.

This course was delivered to the 13 students enrolled in the unit ED 3282. Audiographics is best suited to small groups of students at separate sites and 13 students was an ideal class size for this project. The course comprised five 45 minute sessions with an audiographics link and eight one hour sessions where students worked independently. The audiographics lessons were delivered by the first author from a remote campus while the second author acted in a support capacity to the students on the remote campus. The program ran across a six week period during which time the students were required to complete a range of tasks leading to the final sessions where students worked in pairs to plan and deliver an audiographics lesson to their peers. Throughout the course, communication with the distant lecturer was limited to the audiographics technology and telephone, a restriction that raised students' awareness of the conditions of learning through such technologies.

In each audiographics lesson, four students in the class sat at the computer and interacted with the distant teacher. The remainder of the class sat behind, following the lesson and reflecting on the teaching and learning strategies being employed and the responses of the students. At the end of each lesson, the group assembled for 15 minutes to discuss the teaching that had taken place and to consider various aspects of the learning environment unique to this form of teaching and delivery. By the end of the course, most students had been active participants in two, and observers of three, audiographics lessons.

In the process of conducting the course, we established a series of research questions that we sought to investigate as a means of evaluating the innovations we were using and as a means to improve the course for subsequent implementations. The particular areas of inquiry addressed by this research were: students' responses to the alternative instructional format; the relative effectiveness of the different components of the program; and the extent and scope of the learning;

Throughout the course, a number of data collection methods were employed. Students were asked to complete questionnaires at various stages and records were kept of their work across all activities. Interviews were conducted among the students and the lessons delivered by students in the final sessions were recorded.

Results

1. Students' responses to the alternative instructional format

When at the end of the course the students were asked to indicate the main ways in which this course differed from others, by far the most common responses were the high levels of practical work involved and the use of the computer technology. Perhaps the views of the students were well summed by one who said:

> "In other courses, we would have read or been told how the technology works, in this course, we were shown and we experienced it."

When asked to suggest the ways in which this course was superior to others, the more common responses were, that in comparison to others, this course:

- was more practical;
- used technology as a fundamental component;
- catered better for the needs of individual students;
- was very motivating and stimulating;
- encouraged and supported higher levels of student participation; and
- compelled students to keep up and to learn what was going on.

We also asked students to inform us of ways in which the course carried disadvantages or was less effective than others. The main responses were of the form:

- using technology hinders learning when technical problems arise;
- not being able to see the teacher is a disadvantage;
- not being able to form a relationship with the teacher was a problem; and
- it takes longer to learn by doing than by lecture mode.

One interesting response from a student was the comment that:

> "I'm not sure that audiographics is as good as people claim. I personally learned very little from the audiographics sessions. Everything I learned in the course, I had to teach myself."

We took this comment to be more positive than negative. It demonstrated to us that the student recognised that he was very much responsible for his own learning and had learned through his own activities. At the same time it demonstrated that there may be students who feel that they learn by *being taught* and when this aspect is removed from the classroom and the onus placed on the student to learn, there may be some who will not appreciate the different teaching style despite its effectiveness and learning potential.

2. The relative effectiveness of the different components

To gain students' perceptions on the component of the course through which most was learned, at he end of the course each was asked to rank the different media/instructional components. The results of this ranking are shown in [Tab. 1]. The sum of the rankings provides an index, the smaller the number indicating a perception of a higher effectiveness and contribution to learning.

The students' results clearly indicate that they considered the practical components to have contributed the most to their learning. The three components with the lowest indices were: the audiographics lessons themselves; the lesson planning tasks; and the actual lesson delivery. The two components that were considered to contribute least were the WWW reading activity and the video, both of which were rich in information but presented in very passive modes.

student number	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
audiographics	1	2	1	4	2	5	5	1	2	3	1	1	1	**29**
readings	3	1	2	1	6	7	7	5	1	5	3	4	5	**50**
World Wide Web	7	7	7	7	7	7	7	7	7	7	6	7	7	**90**
video programs	6	5	6	6	5	6	6	6	6	6	7	5	6	**76**
computer lab.	4	6	5	5	3	2	2	4	5	4	2	6	4	**52**
lesson planning	5	4	4	3	1	4	4	2	4	1	4	2	3	**42**
lesson delivery	2	3	3	2	4	3	3	3	3	2	5	3	2	**38**

Table. 1:
Rankings showing the students' perceptions of the components of the course which contributed most to their learning

The contribution of the audiographics lesson presentation to learning was evident in ways other than student judgments. For example, at the end of the first lesson before any theoretical discussion was held on effective pedagogies for audiographics teaching, students were asked to comment on what they considered would be important instructional considerations for teaching. Students commented on the need for:

- lessons which could capture and maintain interest;

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- higher levels of student activity than conventional classrooms;
- strong management routines;
- instructions and directions to be given clearly and succinctly; and
- smaller rather than larger groups in the remote classrooms.

It was clear from students' responses that through practical participation in audiographics sessions, much of the description from the textbooks was already known by them. It was perhaps this reason that caused the WWW document and video programs to be considered the least effective components in the course: most of the information carried through these media had already been gathered by students through experience and there was little more that could be learned from these other sources.

3. The extent and scope of the learning

The measure that we chose to use to assess the scope and extent of learning in this project was students' performance in planning and delivering an audiographics session at the end of the course. The use of this activity provided an assessment that truly reflected the intended learning outcomes.

The criteria by which students were assessed in this exercise were:
- the planned lesson, including the nature of the learning activities planned, the instructional screens created, the planned learning sequences, the supporting materials developed; and
- the lesson delivery; the quality of the interactions, the nature of the instructor-student communications, management strategies employed.

We observed six lessons presented by students in team-teaching modes. In all instances the lessons were well prepared and reflected a good knowledge of the forms of teaching activity required to successfully learning at a distance with this technology. The real measure of the success project was in the lesson delivery. All six groups delivered lessons that although varying in amounts and levels demonstrated the following characteristics:
- sound management strategies;
- engaging instructional sequences;
- low levels of teacher-talk;
- student collaborative and cooperative activities;
- motivating and stimulating presentation modes; and
- computer as well as oral interactivity.

Perhaps the most telling indicator of the scope and extent of the learning came from students' responses at the end of the course. While many had been anxious and concerned participants on day one, by the end of the course, most students indicated that they recognised that although they didn't know all that was needed for total independence at this stage, they felt comfortable enough to want to become involved in this form of teaching in their initial appointments. They felt confident that they had the skills and knowledge to at least make a start and learn what ever was needed from there. Even those students with least computing skills demonstrated this form of confidence. We were heartened to see that most students had developed a confidence towards self-sufficiency and had expressed the view that in the future, they could learn through their own resources.

Summary and Conclusions

This paper has described a project in which students learned practical skills of, and a theoretical understanding about, a distance education technology in a course where the distance education technology itself was used as the delivery medium. This method of on-campus course delivery was characterised by a teaching program which involved such instructional attributes as: knowledge construction; authentic contexts; student-centred learning and collaboration. An evaluation of the course demonstrated high levels of student performance and satisfaction with the course and provided feedback which indicated that the project was very successful in most regards.

The evaluation revealed that students were very positive about the alternative instructional format used with most seeing it as superior to conventional instruction. There was evidence that all the characteristic attributes had a positive impact on student learning and there were a number of learning outcomes that most likely could not have been achieved through conventional teaching means. The instruction led to the development of the necessary skills and knowledge needed to develop effective teaching programs with this technology and it was evident that much of the learning came from students activities and experiences rather than from content gained from the course materials. The components of the course which the students saw as most effective were those related directly to practical teaching with the technology. Our secondary aim of developing students ability for self-instruction also appeared to have been met with most students demonstrating high levels of competence and confidence in independent and self-regulated learning activities.

Buoyed by the success of the project, we plan to implement the course again drawing on the more successful components and adding new features to extend the scope and learning potential. We are planning to include students from similar courses in other Australian universities in the next course. To cater for the changed nature of the learning environment that this will bring, we plan to encourage and enable communication and collaboration between the remote learners through such associated technologies as e-mail and listservs as described by [Yakimovicz and Murphy 1995]. Each of the new features will enable students to extend their knowledge of effective teaching strategies and technologies complementing teaching and learning at a distance and provide new tools for personal development.

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Exploring the Scaleability of Object-Oriented Environments that Support Synchronous Distributed Collaboration

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Introduction

There are a variety of technological means for supporting synchronous collaboration. It is clear that the number of individuals simultaneously using such systems and whether or not they are co-located alters in fundamental ways the patterns of interaction. If such systems are to be used in education one question of key importance is, are there pedagogical thresholds on scale of simultaneous use for particular learning environments which build on such technologies? Over the last ten years the authors have designed and evaluated a number of object-oriented environments that support the learning of concepts in science. We are committed to an object-oriented approach for various reasons, the most important being the ease with which direct manipulation interfaces can be supported. For this paper we briefly summarise a re-evaluation of that work from the perspective of constructing a taxonomy of learning behaviours observed in different technology mediated collaborative settings. The paper will conclude by describing the results from a new study currently in progress to systematically evaluate Kansas, a new very general and powerful environment that supports synchronous distributed collaborative learning.

Context

In recent years a number of researchers have investigated what happens when students work collaboratively, especially in the domain of science problems. In many circumstances students working together on a problem benefit more than those working alone. But how do these benefits arise? Some workers attribute learning gains to the increased cognitive resources available for solving the problem (two heads are better than one), some to increased verbalisation while working, some to the beneficial effects of externalising conflict and some to the co-construction of knowledge. Thus, there is still a difference of opinion as to exactly how working with one or more partners enhances learning, and, in particular, what makes an effective setting for collaborative learning. As benefits also appear to be dependent on a number of task specific factors, research on these raises a number of questions about how to best design collaborative learning experiences. The two key dimensions of variation this paper is concerned with are the number of learners working together and whether or not they are physically co-located. We are particularly interested in the ways in which the benefits of collaboration can be harnessed for collections of students learning science at a distance from each other. In our past work we have examined the benefits for science students of working with simulations, and exploring the potential for students of simulations to solve problems of various types. The technological basis of this is our past work on the Alternate Reality Kit (ARK), SharedARK and DM3 (the Direct Manipulation of Mechanical Microworlds) . With ARK we worked with co-located pairs, with SharedARK we have worked with physically separated pairs and with DM3 we studied co-located triads of learners.

ARK - Alternate Reality Kit

ARK (Smith, 1990) is a system for creating interactive animated simulations implemented in the Smalltalk-80 programming environment which includes some unique features chosen to make its simulations both powerful and unique. The interface is faithful to a physical world metaphor - all objects have a screen image, a velocity and can experience forces. Even the laws of physics can be treated as objects and therefore manipulated and changed. Our experiments with instructional physics simulations (for example teaching the conservation laws) implemented in ARK (Smith, O'Shea and Scanlon, 1987) convinced us of the value of interfaces based on physical metaphors and demonstrated that the ability to perform experiments where students could see the effect of the laws of physics being otherwise had enormous educational potential, and that the design of suitable tasks played a large role in the success of the simulations. In our work with ARK we noted that its richness and complexity was such that a classroom of users observing a single workstation 'driven' by one of them could become distracted and demotivated. On the other hand lone users did not perform as successfully as pairs of users exploring simulations that were sometimes designed to replicate real world phenomena and sometimes designed to illuminate the laws of physics by breaking them. There was also interesting variation in the styles of task division adopted by the pairs which ranged from very even turn-taking to distinct roles of driver and navigator.

SharedARK

The design of SharedARK, a distributed version of ARK, allowed us to experiment with pairs of users working together while communicating from remote locations with an audio and video link. This sort of technology is vitally important for distance education institutions. A system for remote collaboration developed by Smith (1992) allowed two users in separate rooms each with a workstation to run a shared physics simulation. A number of pairs of graduate students were linked via various forms of communications devices. Some had only an audio link, whilst others had the audio plus a camera monitor device called a video tunnel which enabled eye contact. These conditions were compared with situations where participants worked together in a room, either side-by-side at the interface, or on opposite sides of a communal desk. We observed distinct effects on the problem solving performance of the students (see Scanlon et al., 1993) revealed by video protocols analysed and utterances related to eye contact and simulation events categorised in a variety of ways using a methodology described in Taylor et al. (1991). One finding from this experiment was the important role of eye contact through the video tunnel in establishing successful collaboration, and in particular during the high-level planning stages of the interaction. Another finding was that the distributed technology increased the social distance between the pairs of users and that this prompted the users to be more articulate about their problem-solving strategies and more careful about how they used talk in guiding collaboration. This experiment showed that such distributed technology was usable but mediated collaborative problem-solving behaviours that were different in kind from those observed when the same simulations were used by physically co-present pairs.

DM^3 - Direct Manipulation of Mechanical Microworlds

"The Conceptual Change In Science (CCIS) project" (O'Shea et al 1993) aimed to improve the science understanding of a mixed group of thirty thirteen year olds using specially designed computer software. The concepts to be studied were those from Newtonian mechanics. The software consisted of scenarios implemented in DM^3 (the Direct Manipulation of Mechanical Microworlds) computer program written in Smalltalk-80, strongly influenced by the design of ARK. These scenarios were brought to life in simulations which children could use both in structured experiments and in an informal way. The scenarios combined with support materials (e.g. worksheets) to form an integrated teaching package which also included 'real' practical experiments. The scenarios were constructed to provide opportunities for pupils to construct a Newtonian set of rules for force and motion in a supported software environment, through observation of patterns of events and data on the screen. Time was equally divided between 'real' and computer practicals. Children worked in affinity groups. Each scenario is designed to address particular misconceptions. and the pupils need to collect empirical data about prototypical motions, and to identify relationships between variables. Computer experiments based on the scenarios combine with support materials such as worksheets and real practical experiments combine to form an integrated teaching package. The practical work requires pupils to make predictions about the outcomes of either type of experiment, giving the reasons behind their predictions and then check the outcome. In the CCIS studies we noted that it was not possible to support the formation of mixed gender affinity groups but the single gender triads were very productive and characterised by very clear role division rather than turn-taking amongst the individuals and the emergence of a new co-ordination role which we had not observed in our earlier studies with pairs.

Kansas

This is a distributed classroom which allows several physically distributed users to move about in a 2D space (called "Kansas" because it is very extensive and flat). Moving together and apart in Kansas will make and break audio connections among users so a group can easily divide into subgroups for independent discussions. Users each have a window in which they can see their local portion of Kansas. This window may contain objects relevant to the subject matter. Each user sees a small local rectangular portion of Kansas. Users can scroll their viewpoints across the vast surface, causing their rectangles to overlap in order to collaborate, or can move away from others to work alone. Kansas users can be anywhere in the physical world. Kansas supports interactive animation. Kansas is written in itself - it is integrated with the Self programming environment, so anything can be modified arbitrarily while the system is running. The Kansas shared space is written in the Self language. Our previous experiments with SharedARK suggest the importance of eye contact in establishing successful joint working, but recent work by Whitelock et al. (1995) suggests that audio communication might be sufficient for students working on a shared simulation to establish adequate role and task division.

Scaleability Experiment

At the Open University we now have a version of Kansas which supports upto 5 simultaneously active users (or, of course, up to 5 groups of users) and they can be given access to audio or both video and audio links between each of the 5 locations. We are therefore asking what the effects of increasing scale from 2 or 3 active users on the types of behaviours and roles we observed in our earlier studies. We have developed a benchmark group statistical problem-solving task which is simple to state, understand and support in Kansas but which, like many of our standard tasks used in past studies, has a simple solution which is counterintuitive. By constraining ourselves to such a task and by using an environment which has a similar interface to that used in our previous studies we are able to focus carefully on scaleability and contextualise the results we get from this study with our past ten years work in this area. The experimental task involves deciding what advice to give a contestant who is the game show situation where, having chosen one of three doors which might lead to the grand prize, the contestant is shown behind another door which does not reveal a prize and is then asked if they wish to change their choice to the third door. The groups of subjects explore the problem with the aid of a shared simulated game show setting, a shared note-taking tool and a remote human host who communicates via audio or video link. The subjects display many standard misconceptions associated with probabilistic reasoning. Many are convinced the random means fifty per cent of the time. They display superstitious behaviour with respect to patterns and in one case became convinced that one of their group was 'lucky'. Non-mathematical notions of fairness are also invoked, such as that it must now be the middle doors 'turn'. Subjects also often make explicit the idea that changing door choice entails the higher 'emotional risk' of leaving a choice that turns out with hindsight to have been right.

Preliminary Results

The preliminary results of our studies can be related quite nicely to our past experiments with SharedARK and in the CCIS project. The difference between the audio only situation and video link situation is preserved in the Kansas context. In the CCIS experiments we found that three students working together could divide tasks of these types between themselves in a rational and effective way. This also holds in the current round of Kansas experiments and for educational purposes we are becoming more and more convinced that three students working together gain more incidental learning benefit than two or four. One tidy three way division that was adopted was one person choosing the door, one person operating the simulation and the third person taking notes. We noticed that moving from groups of three to groups of four appears to add dramatically to the extra negotiation about how to organise the task. Our experience with a groups larger than three is that the overhead of, for example, deciding which part of the task to do next can grow out of all proportion to the actual problem solving necessary to make progress. One ameliorating tactic that we have noticed groups larger than two learn to adopt is to indicate preferences and choices by the location or movement of their mouse cursors on the shared screen. We are interested to discover whether other economical non-verbal methods of joint problem solving are evolved by groups of learners or problem solvers using systems like Kansas. The main result of our research is that learners behave differently when they use systems like Kansas from the way they behave when they are in the same room and that the dynamics of groups of learners alters in very distinct and measurable ways depending on the number of subjects who are simultaneously working together. A key aspect of shared system use that affects behaviour is the clarity and economy of the note taking methods devised or adopted by the group. Some groups generated chronological and detailed records of every use they made of the simulation. The level of detail was such that they had to scroll in a shared window to view the data and they often "could not see the wood for the trees". In these situations groups often agreed on counterfactual summaries of the data that matched their expectations or prejudices, such as its "fifty fifty' either way. Larger groups were more likely to record unmanageable amounts of data and to agree incorrect summaries. On the other hand, when groups devised simple highly focused ways of summarising the data that could be viewed in a single window they were much more likely to identify and resolve mathematical misconceptions. The most elegant summary was a two by two matrix of success/fail versus stick/change where the appropriate cell was updated by one of the subjects after each go at the game. One group also used the share note-taking tool to explore illuminating hypothetical cases such as the 100 door case. So one important gloss on our early results is that not only do groups of size smaller that four problem-solve together more effectively using the technology, they also devise more effective shared tools to support their learning and exploration.

Concluding Comment

We believe that object-oriented environments that support synchronous distributed collaboration will play an important role in the support of distance learning. We conjecture that it will be possible to demonstrate that much larger numbers of simultaneously active learners, distributed as individuals and small groups will be able to productively learn together. At the same time, there are simple a priori arguments that say there has to be threshold limits to the number of individuals and groups who can usefully be coactive. Smith's successfully implementation of Kansas now makes it possible to test our scaling up of collaborative group size conjecture and to explore the scaleability limits of this new technological support for synchronously working collections of distant learners..

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PACER (Personally Active Computing Exploration Resource): The Development of an Interactive Learning System Using Object-Oriented Programming Methodologies and Java

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Abstract: PACER (Personally Active Computing Exploration Resource) is an online learning resource that enhances the viability and efficacy of education through interactive learning. PACER provides a self paced, interactive learning system by which students learn complex and abstract concepts which frequently defy traditional classroom teaching methodologies. Development of this national model is accomplished through an object-oriented design, implemented with the JAVA programming tool and delivered across multiple computer platforms through the World Wide Web. In this paper we present the design and implementation issues of PACER system together with some examples of interactive learning.

Introduction

PACER is an interactive learning environment designed to engage students in learning. The goal of the project is to develop an educational system which takes advantage of emerging technologies to provide interactive, demand-driven simulations which enhance comprehension of abstract concepts in computer science. The PACER system includes three fundamental objectives: simulation and experimentation, connection to supplementary information and delivery to a wide audience across multiple computer platforms. All three objectives are required to support the educational demands of students who struggle with difficult theoretical material, seek access to information round-the-clock from home and work and use a variety of computer platforms. Interactive environments such as PACER are an effective, readily accessible means to support active student learning.

The term interaction has a significant meaning in our definition. Even though every World Wide Web-based learning environment can be considered interactive, they are actually passive learning environments. For example, World Wide Web learning material on modern art allows one to browse through several pages of art by popular artists. It will not allow one to manipulate the artwork in anyway. The essence of science and engineering is active learning through manipulation and observation. In the PACER system, students can interactively manipulate the objects (models), observe the changes, and improve their level of comprehension of abstract concepts.

Implementation Strategy

Programming Language Selection

PACER is a learning tool designed to capitalize on the benefits of a distributed system. The design standards include (1) internetworking/World Wide Web support, (2) complex graphics (3) interactive capabilities (4) object orientation, and (5) user friendly programming. It was critical to implement a system which offered platform-independence while being sophisticated enough to adequately support graphics and user interaction.

Several platforms including TCL and TK [Ousterhout 1994] were considered. However Java [Cornell & Horstman 1996] which is a recently released, object-oriented and independent programming language from Sun Microsystems, appeared to be particularly appropriate for design implementation.

The language of Java [Geary & McClellan 1996] is well suited to inter-networked distribution because of its hybrid compiled-interpreted nature. Java source programs are compiled into a format called bytecodes. Java bytecodes, programs, also called classes, are designed to "run" on a hypothetical computer called the Java Virtual Machine (JVM). Thus, a single set of source code and single compilation is supported on any platform type running a JVM. Platform independence was particularly important for the PACER project. Effort is focused on program development and enhancement, rather than porting to several hardware and software platforms. Java's ability to provide platform-independence is also beneficial to students. Without this capability, users would be denied access to the PACER simulations due to a mere lack of access to "supported" hardware or software platforms. Java programs can be readily distributed via the World Wide Web by embedding the programs (called applets) into standard hypertext documents through the use of special HTML tags. Because today's popular browsers, versions greater than Netscape 3.0 and Internet Explorer 3.0, support Java applets, PACER can be effectively distributed to users. Critical to implementation was Java's ability to support graphical demonstrations of abstract concepts as well as support user input interfaces. Review of Java's performance in numerous applet development concluded that all graphic and user interaction design standards were satisfied.

Although Java provides the necessary networking, graphics, and interactivity support, if the language was arcane and had an extensive learning curve, it could not be used in a project which demands efficient simulation development of applets. Syntactically, Java is a not-too-distant cousin of C++ and thus relatively familiar and programmer friendly. Another benefit is the object-oriented nature of the Java programming language which maximized code reuse and encapsulation. Despite the recent unveiling of Java as a language, it is advantageous for software development of the PACER system because it did not require mastering a vast library of objects and methods to perform routine programming tasks, such as the Microsoft Foundation Class (MFC). Java, in its current form, provides more than adequate tools to develop detailed, aesthetically-appealing, animated, and interactive simulations.

Object Oriented Design In Java

Because C++ was developed to promote object-oriented programming [Stroustrup 1991, Jacobson 1995] while maintaining backward-compatibility with C, it is incapable of being a truly object-oriented language. That is, C++ was not designed from the ground-up to be an object-oriented programming language. Rather, it may be more accurately described as an extension of a procedural language, C, to support object-oriented programming design. Java, on the other hand, is a purely object-oriented programming (OOP) language. All Java programs must be written from the perspective of the creation and manipulation of classes. Procedural programming methodologies are not supported. Java does not allow one to create and call functions. All activities in a Java program take place from the perspective of creating the required objects and invoking their public and protected methods and data members.

Java's purely object-oriented focus provided a unique opportunity to the PACER team to evaluate the efficacy of using OOP in a large-scale software development project. Results of 10 months of development confirm that two cornerstones of object-oriented programming: (1) inter-object communication and (2) code modularization and reuse provide the fundamental basis for developing simulation capabilities in an interactive learning environment. Two implementation examples illustrate the advantages provided by each of these facets.

Inter-Object Communication: The TALU (Tiny Arithmetic & Logical Unit)

In this first example we show the advantages and importance of inter-object communication of object-oriented design. One of the first topics encountered by the beginning computer science student is computer architecture. Students are exposed to Boolean logic and its implementation through logic circuits. Several applets were developed to demonstrate the Central Processing Unit's (CPU) internal workings. These applets range in complexity from simple logic gates to a fully operational CPU simulator, the Tiny Arithmetic & Logical Unit (TALU). The TALU [Fig. 1] graphically demonstrates the manner in which computer macro-instructions, such as LOAD, is executed as a series of micro-instructions. Students using PACER can visualize how each of the micro-instruction sets activate a series of control wires in the CPU while an instruction is being executed.

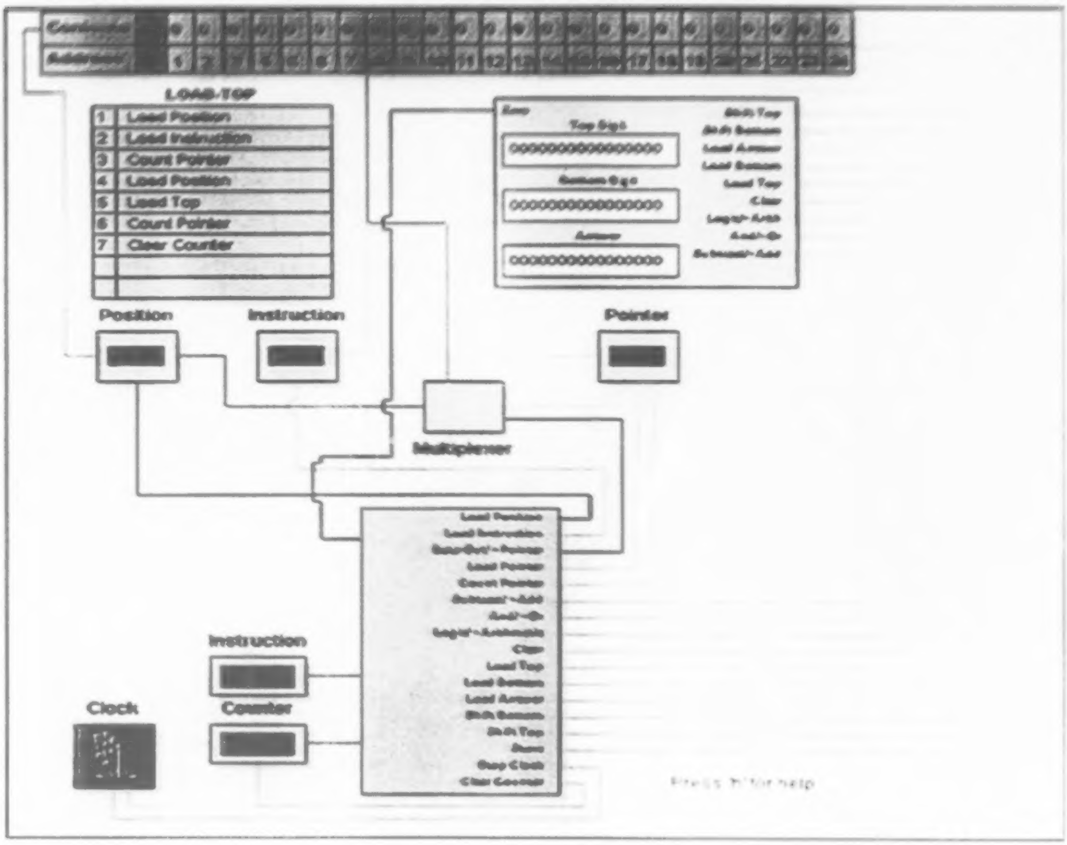
Contents
Address
LOAD-TOP
1 Load Position
2 Load Instruction
3 Count Pointer
4 Load Position
5 Load Top
6 Count Pointer
7 Clear Counter
Top Sign
0000000000000000
Bottom Sign
0000000000000000
Answer
0000000000000000
Position
Instruction
Pointer
Multiplexer
Instruction
Clock
Counter
Load Top
Clear
Press 'h' for help

Figure 1: The TALU Applet

When implementing the TALU, it became clear that the usage of inter-object messaging, which allows several objects to communicate in a synchronized manner during execution, was going to be critical to the TALU's implementation. The TALU uses inter-object communication extensively throughout execution by synchronizing events and data between memory, instruction display, the arithmetic and logical unit, and the various place-keeping memory registers. It is the seamless synchronization that results in realistic simulations. For example, when a new macro-instruction needs to be loaded from memory for execution, the TALU's driver object, called FP, requests the instruction (which is stored in the next segment of "memory") from a memory object. The memory object retrieves the instruction and relays it back to FP, which in turn forwards the information to the macro-instruction decoder. The macro-instruction is then broken down into a sequence of micro-instructions, which are displayed on the screen and returned to FP. FP then coordinates the incremental execution of each micro-instruction by communicating with other TALU objects, such as instructing the ALU object to perform an addition operation or requesting the PC to increment the program counter. In addition to the ability to send and receive processing or data retrieval requests, Java classes have their own graphics capability. In theory, an object can be placed on a blank canvas and by following the proper interfaces defined for that object, it can act on its own or can be interfaced with various other objects to serve a particular function in a communicative object environment. For certain events, the TALU applet as a whole needs to refresh itself graphically. Rather than creating a centralized drawing class, the TALU's objects provided the ability to "draw themselves" when requested by FP. This permitted true data encapsulation, allowing each object to exists as its own entity which could operate on its own or alternately upon a request from FP.

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Code Reusability: The Turing Machine

In this example, we show the second component of OOP, the emphasis on code modularization and reusability, is best illustrated by a pair of programs developed for the algorithms module of an introductory computer science course. One of the classic methods of instructing students in the manner in which algorithms are translated into computer instructions and subsequently executed is the Turing Machine.

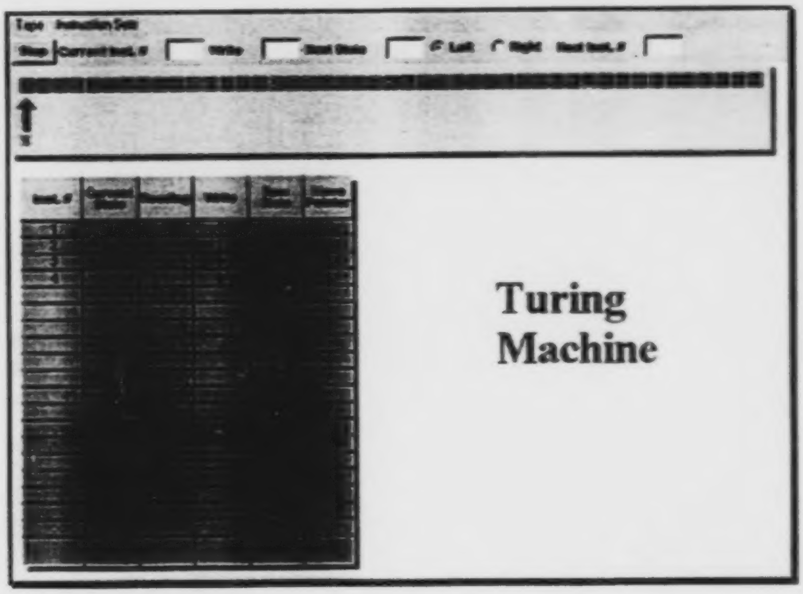

Figure 2: Turing Machine Version 1 (The "Step-Through" Machine)

Two Turing Machines were developed for the PACER project, each serving a distinct purpose in the instructional process. The first machine [Fig. 2] was designed to illustrate for students the basic operation of a Turing Machine, particularly from the perspective of instruction selection and execution. The applet contains a series of simple, pre-defined instruction sets, any of which may be selected by the user. The user must then create a tape and attempt to step through the execution cycle. Before any given instruction will execute, the student must first correctly determine the applicable instruction, the value which will be written to the tape, the pointer's new state, the direction in which the pointer will move, and the next applicable instruction after the pointer has moved. By requiring the student to find the applicable instruction and more importantly, predict the next applicable instruction after the present one executes, a student will be forced to learn the structure and operation of a Turing Machine and its relationship to the instruction set.

The second machine [Fig. 3] was designed to behave more like a "true" Turing Machine. The student must first create an instruction set, create the tape from which the instructions will operate, and then "execute" the program on the machine. This allows the student to develop their own algorithm to solve a given problem and the test the correctness of the algorithm by running it on the intended machine.

When designing the Turing Machines, emphasis was placed upon making the applets as "application-like" as possible. Thus, all editing activities were designed to take place through the use of drop-down menus and pop-up windows, much the same as a "true" application would behave. This created a unique design problem from the outset, since Java applets do not directly support a menu-driven interface. The solution was to create a "master" Java applet which consisted simply of a button, which, when depressed, would display the primary Turing Machine window. Once this initial hurdle was cleared, the remainder of the design process was directed toward general application structure.

Consistent with basic object-oriented design practice, an attempt was made to develop as many general-purpose classes as possible which could be utilized by both machines with little or no modification. It was soon

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discovered that the fundamental internal workings of the Turing Machine could be implemented as a series of general purpose objects, which required minor modification between machine versions. The basic object hierarchy is similar for each version of the Turing Machine [Fig. 4 & Fig. 5]. The primary difference is the manner in which the Instruction Set class was implemented. In Version 1, the Turing Machine instruction set was predefined and thus relatively simple to implement. However, in Version 2, facilities had to be provided to allow the user to define the instruction set.

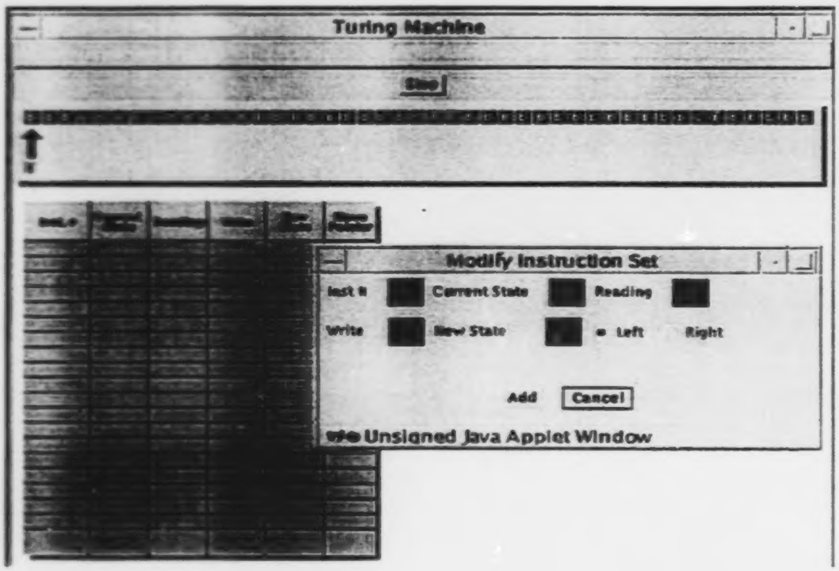
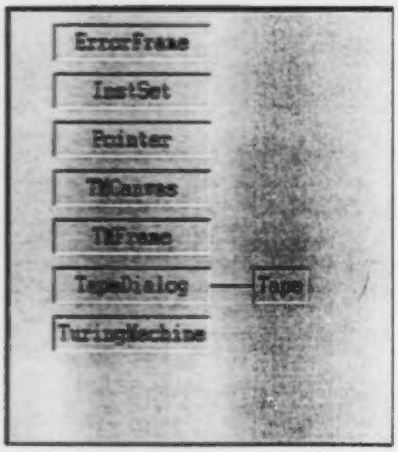

Turing Machine
Modify Instruction Set
Inst #
Current State
Reading
Write
New State
Left
Right
Add
Cancel
Unsigned Java Applet Window

Figure 3: Turing Machine Version 2 (The "True" Machine)


ErrorFrame
InstSet
Pointer
TMCanvas
TMFrame
TapeDialog
Tape
TuringMachine

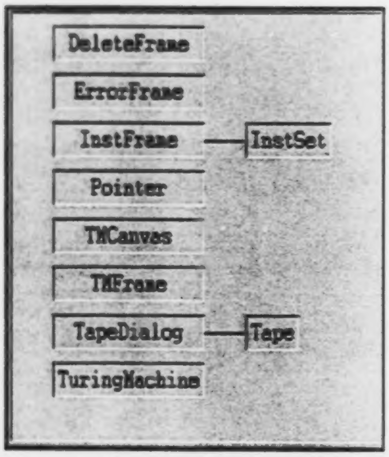

DeleteFrame
ErrorFrame
InstFrame
InstSet
Pointer
TMCanvas
TMFrame
TapeDialog
Tape
TuringMachine

Figure 4: Object Hierarchy - TM Version 1 **Figure 5**: Object Hierarchy - TM Version 2

In order to maximize code reusability, care was taken to ensure that the Turing Machine's Instruction Set object was in the same format and not impacted by which instruction definition method was selected (i.e. hard-coding for Version 1 & user-defined in Version 2). Thus, the actual InstSet class was not significantly modified between applets. However, in order to facilitate user definition of Turing Machine instruction sets, InstSet was transformed into a derived class of a new object named InstFrame. InstFrame is an extension of a Java Frame object, and essentially creates a pop-up window in which the user may input the required values for a single

Turing Machine instruction. By making the actual instruction set a derived class of the InstFrame object, communication between the values input by the user and placement into the InstSet class data members was facilitated. Again, Java's emphasis on object-oriented design, which by it's very nature maximizes code reusability, made implementation of a fairly complex program much easier than would have been the case using procedural methodologies.

Initial Results and Feedback

As noted above, the PACER team has developed several applets. At present, the primary focus of development has been to demonstrate basic hardware and logic concepts. Thus, Java has been successfully utilized to produce numerous interactive circuit diagrams and memory register representations. One of the most time-consuming, complex and ambitious applets developed thus far has been the "TALU" simulation. The TALU (Tiny Arithmetic & Control Unit) simulates the operation of a microprocessor control unit at its most basic level. Students can design a program using a rudimentary machine language, load that program into the TALU simulator and step through the program's execution. The simulator steps through each of the micro-instructions associated with a macro-instruction, and indicates the data flow path associated with each micro-instruction. Thus, the student can more readily understand the complex interrelationship between memory, CPU clock, program counter, and processor registers.

Another fairly large simulation is the set of two Turing Machines. The first machine helps the student understand the abstract concepts of a Turing Machine's execution and structure. The student selects any of three pre-coded instructions sets and enters starting tape values. Given the current state and pointer reading, the student must predict: (a) what value will be written to the present cell; (b) what the next state of the Turing Machine will be; (c) which direction the pointer will move; and (d) what the next applicable instruction will be. The machine will not "execute" the instruction until the student makes the proper selection. The second machine is more in the nature of a "true" Turing Machine. This interactive simulation requires the student to create and test their own Turing Machine tapes and instruction sets.

Formal testing and evaluation procedures are underway. However preliminary studies reveal that student reaction to the prototype PACER simulations has been extremely positive. Students indicate that they use the PACER system to visualize complex material that can not be easily understood in lecture or in textbook form. They seek to experiment with the interactive capabilities along with gleaning additional theoretical information from the explanations that accompany each of the simulation packages. Approximately 97 beginning computer science students have utilized and evaluated the PACER system.

Conclusion

The interactive learning system called PACER has been under development for less than a year. Although many features of PACER have yet to be implemented, the PACER team is quite satisfied with (1) developing the system using an object oriented programming language called Java and (2) positive reaction by approximately 97 students enrolled in the introductory computer science course. Although Java's recent release makes programming the simulations a challenging exercise, it has provided a wonderful mechanism for attaining the ambitious goals set by the PACER team.

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The Interactive Story: Fostering School Community Through Multimedia Projects.

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Abstract: This paper explores one model for developing multimedia and a spirit of cooperation. It is based on a course I taught to 6th graders at the Exploration Summer Program in Southbourgh MA and work I am currently doing at the Isidore Newman School in New Orleans, LA. Each class created a hypermedia game located in a virtual representation of their school. Players of these games travel through the school, interact with "teachers" and "students," and try to solve mysteries. The process of creating this game can be broken up into three conceptual categories. First of all, exercises stressing cooperation prepare the student to work together on the project. Secondly, lessons focusing on the principles of Multimedia Design provide the skills students need to create an exciting game. Finally, students explore of the ways that Hypertext links provide the means to connect individual student efforts into a collective project.

Introduction

New Media combines images, text, video, and sound to produce complex works of art. Successful multimedia projects require the coordinated efforts of many people. Facilitating cooperation between story tellers, visual artists, writers, and musicians is a central concern of professional multimedia developers. This concern is even more pronounced among teachers using computers in their classrooms. After all, a teacher wants more than a slick finished product. S/he must also try to engender a supportive classroom environment where learning and community can thrive.

This paper explores one model for developing multimedia and a spirit of cooperation. It is based on a course I taught to 6th graders at the Exploration Summer Program in Southbourgh MA and work I am currently doing at the Isidore Newman School in New Orleans LA. Each class created a hypermedia game located in a virtual representation of their school. Players of these games travel through the school, interact with "teachers" and "students," and try to solve mysteries.

The process of creating this game can be broken up into three conceptual categories. First of all, exercises stressing cooperation prepare the student to work together on the project. Secondly, lessons focusing on the principles of Multimedia Design provide the skills students need to create an exciting game. Finally, students explore of the ways that Hypertext links provide the means to connect individual student efforts into a collective project.

Cooperation

The game design unit begins by breaking the students into three equal groups: the dreamers, the communicators, and the technicians. The dreamers go outside with a teachers aid. The communicators and the technicians stay in the lab with the instructor.

Once outside, the dreamers are lead on a guided visualization. They are asked to "travel" to a safe, beautiful, far away place. When they find this place they are asked to take a mental picture of it. They must remember what this environment looks like. When all the dreamers have a clear picture in their heads of their imaginary environment, they return to the lab. There is one catch -- the dreamers are blindfolded as they return.

Meanwhile, the communicators and the technicians are discussing the challenge that they face. They learn that the blind folded dreamers have a mental image that they must convert to an image on the computer screen. The dreamers will describe the image that they have in their heads. The technicians are the only people allowed to touch the computer, key board, and mouse. Thus, the technicians must respond to the description given by the dreamers. This gives them a great deal of control, but they are not allowed to talk. That is where the communicators come in. As the technician draws, fills, sketches and follows instructions, the communicators can ask the dreamers questions: Is it a dark green or a light green? What kind of trees are on the hill? etc. The communicator is responsible for making sure the technician gets it right.

When the dreamers return to the room, the students use the computers in pairs of three: one dreamer, one communicator and one technician at each machine. Then the difficult process of converting mental imagery into art begins.

The lesson provokes conversation about technical and artistic themes. It encourages students to talk about how to do complex technical operations (i.e. "go to the tools menu and select the icon that looks like a paint brush"). It also places those technical issues in the context of accomplishing a specific and worthwhile goal (i.e. "in my imagination, the river goes through the forest and there is a tree house in one of the trees") which in turn forces communication and collaboration between students who love technology for its own sake ("techies") and students who only become interested in technology when it helps them accomplish specific goals ("pragmatists").

Students begin to think critically about the different elements involved in creating computer art. One needs imagination, technical ability, and the facility to translate between the two. This demonstration has been an effective means of encouraging students with various learning styles and strengths to become excited about computers. When students begin to work individually, they will have a model for the different elements that are involved in creating computer art. For example, if a technically skilled student is having trouble producing his/her own work, the instructor can tell them that they need to do some dreaming. On the contrary, an imaginative student can be encouraged to work on being a technician by learning various functions of a software program (i.e. "try being a technician for a while, Tom").

Additionally, the lesson encourages and models restraint and sharing. Often, certain students attempt to monopolize the computers. If this happens in the future, I can tell the student, "OK, since you are not letting other people have a turn, you have to be a communicator." This creates specific roles that facilitate cooperation and prevent monopolization by aggressive and technically proficient students.

At the end of this lesson, the dreamers take off their blind folds and look at the image that has been created. Each group can present their experience to the class, and the dreamer can comment on the authenticity of the final product. Discussion will ensue about difficulties, frustrations, and rewards of the exercise. The exercise is repeated with students assigned to different roles. This helps students realize that they can play all of these roles despite their initial proclivities.

Multimedia Design

The next step is to help students develop the conceptual, technical, and narrative skills necessary to develop an interactive game. Story telling is an important element of multimedia design. "Round Robins" are an effective method of encouraging students to tell stories collectively. In a Round Robin, one student begins a story. After a certain amount of time, another student must continue the story. This continues until several students have contributed to the story. This process can be done orally (around a camp fire, for example), or textually. I often lead Round Robins in a computer lab, and have the students move one chair to their left every five minutes. The stories are usually quite entertaining, and students listen carefully for their contribution to each story.

One can adapt the basic Round Robin to mesh with the non-linearity of interactive stories. But before attempting a non-linear story, it is a good idea to complete a traditional, liner Round Robin. Break the class into groups (about eight students in each group). Each group has their own row of eight index cards on the floor and each student has eight more index cards in their hand. The students write a few sentences on the card to start the story off. Then, after a few minutes the students move to their left, using one of their own index cards to add to the story that their classmates started. Eventually, each student will get to write the conclusion to the story that they started. In the end, there are eight columns that constitute eight different stories:

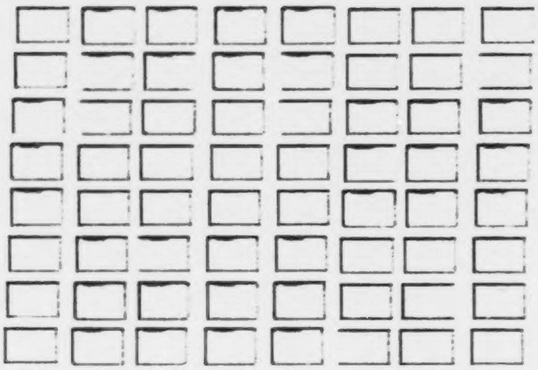

Figure 1: A traditional, liner Round Robin

To read the stories, one would start at any of the top cards and read straight down.

At this point, the instructor can introduce the concept of a non-liner Round Robin with branching choices. This time, a single person writes the beginning of a story on an index card and offers two choices at the end of their story. For example, the first card might read, "Jim is a farmer. Should he plant corn or wheat?" Then a second student has to write two cards, one for corn and one for wheat, and provide two more choices at the end ("All the wheat is dying. Should Jim sell the farm or pray for rain?" or "The corn harvest is bountiful. Should Jim buy a new car or a boat?") This process continues, so that the next student has to make four cards, the next one eight, etc. After completing this exercise the floor will look like this:

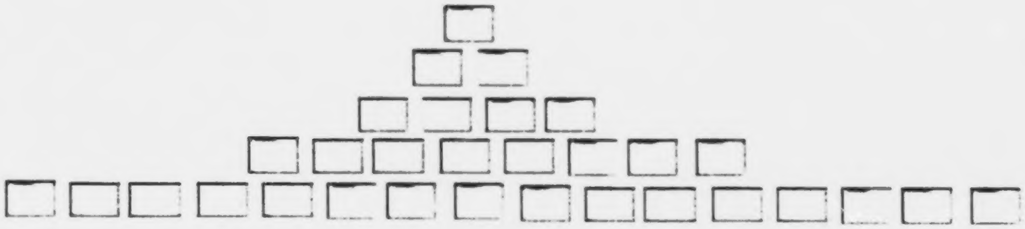

Figure 2: A non-liner Round Robin with branching choices.

To read this story, you would start at the top, and follow any "pathway" down the pyramid.

Clearly, the exponential nature of this process turns the non-liner story telling process into a mess by the fifth generation. The amount of work required to continue the story doubles every generation. Students begin to get frustrated. When students compare the amount of work they spend writing to the amount that people will actually read they become very receptive to alternate modes of developing interactivity.

At this point, the instructor can facilitate a conversation that compares the differences between the linear and exponential stories. Students observations are written on the board and facilitate a discussion on the different modalities of story telling. This distinction will remain relatively abstract at this point. However, this difference applies directly to multimedia design. In programs like HyperCard and HyperStudio, students often run into the same exponential growth problem that resulted from the non-linear Round Robin. Often, students do not understand why it is getting harder and harder to continue their stories. This lesson is designed to give students a concrete, visual experience of exponential growth. This knowledge proves important later when the class begins to create an interactive environment with HyperStudio.

The Round Robin idea is a useful way to explore the different narrative structures one must understand to produce multimedia content. Round Robins are also useful for teaching purely technical skills. Round Robins introduce students to the multimedia authoring program the class will use to create their game. Each student will have their own computer with a copy of HyperStudio installed.
After opening the application, the instructor encourages them to use HyperStudio's painting tools to draw in ten minutes. Then, they move one computer to the left. They add text to their classmate's image. After five minutes, they move left again. This time they are shown how to add sound. They can use a sound from the HyperStudio menu, or record one of their own. When they switch again, they learn how to create a link to another card (complete with a groovy transition effect).

This lesson is designed to get students thinking about how to put images, text, and sound together. At the end of the exercise, we can go around the room and experience every multimedia creation. Afterwards, we discuss which projects are effective, and why. Because the projects were produced by several people, criticism is possible without seriously hurting people's feelings. This provokes serious discussion about which techniques are most effective. Even more importantly, this exercise systematically introduces the students to HyperStudio which we will soon use to create our game.

Before we begin working on our game, we need to solve the problem of exponential growth that was identified earlier. We do this, in part, by reviewing successful commercial games. All the students evaluate existing games. MYST serves as our primary example of a successful interactive story. Like many games, MYST avoids the pitfalls of exponential growth by relying on strong spatial metaphors. The story takes place on an island so the narrative is constrained within a clearly defined domain. The user of the game does not feel constrained because it seems natural that islands are spatially bound.

MYST provides an opportunity to sing the praises of place-specific story telling. As the students begin to work together to create a collective story, they are encouraged to develop and map the location in which the story will unfold. The school site provides a familiar location and allows students to reflect upon and position themselves within their school environment. Creating novel and creative stories within the walls of ones own school can be an effective way for students to map their own place within the larger school community. It is also possible to have the action take place in a haunted castle, a sunken ship, an historically important place, or a prominent location in the school's neighborhood. What is important is that spatial metaphors are constraining and enabling the project's development.

In order to ensure that all students are "at the same place," it is important to construct a large, communal map. This map can be loosely based on the map of the school site. It should be large enough so that ten kids can stand around it and see it at the same time. Once the map is constructed, students need to break up the work of constructing the game. They should write their names on the portion of the map that they wish to build in HyperStudio. As they work, they will begin to identify the students who are working on rooms or hallways that connect with the area they are building. As they work they will need to consult with each other and the map to make sure their visualizations are compatible. At this point, however, they do not link to each other. It is enough to construct a navagatable room in which a user can turn in various directions. Students are challenged to visualize and simulate three-dimensional space.

Hypertext: Linking it All Together

Hypertext facilitates the dynamic linking of diverse media. In the context of this project it allows students to connect their individual work together to create a collective project. In this respect, hypertext facilitates a happy marriage between individual expression and participation in collective life. The World Wide Web is one example of this. Individual pages are linked together to create a globally accessible information resource. Pages created by different authors in different parts of the world can be included on the same "links page" and form a resource for a community of scholars or hobbyists.

In my class, students utilized hypertext to connect their work to their classmates work. An intense period begins where students begin to "link to each other." Eventually, the whole game ends up on a single hard drive. This requires flexibility and cooperation. Students must adapt their individual creations to the specifications of other students work. Hallways must lead to doors, sections of courtyards must be connected together, and secret passage ways need to lead to somewhere interesting. The spirit of collective accomplishment makes changing personal work bearable.

Conclusion

When everything is linked, the beta version of the game is completed. Using the local network, the game is copied onto all of the hard drives in the lab. Working together, the class created a quality control rubric that we used to evaluate the Beta version of the game. Everybody plays the game while looking for bugs. When someone finds a bug they fix it on the master copy of the program. At least two class periods can be spent debugging. When this process is finished, the 1.0 version is ready for release. Once again, all of this is copied onto all the hard drives. This time, however, members of the larger school community are invited to play the game. This allows parents, administrators, and other students to experience the multimedia extravaganza that the class has created.

Feedback from the school community may result in a few suggestions for improving the game. After these are completed, it is time to compress the game into an installer-maker. These are available commercially and as shareware. The game should fit on 2-5 disks that can be installed on a hard drive in the same way you would install commercial software. By adding custom disk labels, your class can produce an extremely professional-looking piece of software. Your students will have something that they can be proud to take home to their friends and family. More importantly, they will feel a sense of ownership in a collaborative project that connects them to their class and their community.

The User Interface Design of Learner-centred Interactive Multimedia Programs

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Abstract: This paper discusses some issues in the user interface design of learner-centred Interactive Multimedia (IMM), illustrated by a case study of the development of SarcoMotion, a program about skeletal muscle contraction in first year tertiary Human Biology. A constructivist approach was taken to the design of the educational material, and some of the instructional design issues are discussed, in particular, how to achieve a learner-centred environment. The paper also discusses various issues in the design of a user interface which could allow students access to the content in appropriate ways, so they could easily make their own cognitive links.

The development of the IMM program was based on an incremental prototyping model, and this paper traces the evolution of the user interface, based on the educational context in which it was to be used.

Introduction

All students doing Health Science courses at Curtin University complete a first semester unit in their first year which covers basic concepts of human biology, including cells, tissues and the musculoskeletal system. Students are enrolled in a variety of courses, including Nursing, Physiotherapy, Medical Science, Pharmacy, Environmental Health, or are completing an undergraduate Science degree. Students have a range of backgrounds, and diverse skills and confidence levels must be accommodated. For example, some students have good chemistry and physics skills, while others have none at all. Furthermore, many are part-time students, and fit their classes in around work and/or family commitments. Some students also come to the unit with low levels of confidence in learning, and lack the assertiveness which will allow them maximum gain from their tertiary studies.

The unit has a large enrolment of approximately 800, and teaching is by mass lectures followed with much-repeated tutorial sessions in groups of up to 20. The latter are often staffed by part-time tutors and consistency is not always possible.

One week of the unit is about muscles, and, in particular, skeletal muscle contraction. The molecular basis for skeletal muscle contraction is complex and challenging, requiring understanding of dynamic and three-dimensional processes at the sub-microscopic level. The students need to be able to visualise the process of contraction, and understand how the process is controlled and co-ordinated, rather than rote-learning a sequence of events.

Students had obvious learning difficulties in understanding this process in the traditional, teacher-centred approach to the topic. Students could identify the various components, but failed to appreciate the scale of the components about which they were learning. The major learning difficulties were twofold:

- Students had difficulty in visualising what was happening.
- Students had difficulty understanding the complex interactions between the components of the muscle cells.

Interactive Multimedia has advantages over traditional educational media with regard to visualisation of three-dimensional, microscopic and dynamic processes [Phillips 1996, Chapter 1], and it was seen as an appropriate technological solution for the first learning difficulty. The hypermedia aspects of IMM also indicate that it is an appropriate medium for learning about the complex interactions in the process.

A pragmatic, two-stage approach was taken to solve this real teaching and learning problem. Firstly, an animation of the muscle contraction was prepared as a QuickTime movie for use as a presentation aid in the large-lecture situation. A frame of the animation is illustrated in [Fig. 1] of the electronic version of this paper. Secondly, an IMM program was developed as a self-paced resource for use in small group tutorials, so that students recognise the animation they have seen in the lecture and can explore and question it in a less-threatening environment.

The animation, and the ability to control its progress, were found to be very effective means by which the lecturer could enhance student understanding in the lecture situation. However, the purpose of this paper is to describe the development of the interactive multimedia program, SarcoMotion, of which the QuickTime animation was a part.

Instructional Design

As stated above, the dynamic and molecular nature of the process of muscle contraction made interactive multimedia an appropriate tool for visualisation of the process. As well as visualisation, students need to understand how the individual components of the process interact with each other. That is, they have to develop their *own* mental model of the process, and therefore, a learner-centred approach was adopted in the instructional design of the content.

It was not appropriate to use the traditional, objectivist-based approach [Marra 1993] to instructional design in this project, because it is inherently teacher-centred. Also, as pointed out by [Laurillard 1993], "the analysis into components of the teaching-learning process is not followed by any synthesis". The students were already learning about the components - what was lacking was the synthesis of the components into an understanding of the whole.

Instead, the learning problem suggested that a constructivist approach [Marra, 1993] was warranted. A learning environment was required which guided and supported students in their efforts to develop their own mental models and understanding of the learning task.

The material had to be structured in a non-linear fashion in a way whereby students could construct their own meanings and make their own links. However, care had to be taken that the design did not result in a discovery learning environment, where students were left to sink or swim in a sea of information. [Laurillard, 1994] has noted that discovery learning environments can hinder learning because it is assumed that students have good research skills and can find their way through the material. Good students may have these skills, but weaker ones may not.

Laurillard's desideratum is a guided discovery learning environment, where the learner has freedom and control over their activities, but where guidance and scaffolding are provided to the learner to give them a context in which to work.

In the particular teaching situation where this program was to be used, the context of use of the program was clearly defined. The use of the animation in lectures gave students a clear starting point, and a thorough unit outline provided the learning objectives. This reduced the amount of guidance needed to be provided by the computer.

Learner-centred Design

Experience with a number of previous development projects has indicated that traditional linear or hierarchical structures of lesson content [Phillips 1996, Chapter 4] are not appropriate when trying to implement a constructivist approach to learning. The traditional approach uses structured reasoning to build up an argument. That is, one starts at the beginning, and build up arguments one at a time until the final structure of knowledge is revealed. This approach is deeply ingrained in any scholarly pursuit, and is not to be denigrated in terms of coming to an understanding of complex issues. However, structured reasoning is an author-centred approach to knowledge. Transferred to the teaching situation, it is a teacher-centred approach to learning.

If one seeks to design for student-centred learning, an environment needs to be created which encourages research-type activities. That is, an environment wherein the student can access many pieces of information in any way they like, given appropriate guidance, so that they can create their *own* structured argument based on their *own* analysis of the content which they have discovered.

An appropriate design approach for this purpose has been found to be to start with a visualisation of the process as a whole [Phillips 1996, Chapter 4], allowing students to explore as they wish, initially browsing to get a 'feel' for the contents, and then delving into various parts of the content to the depth required. Unlike the traditional approach which starts at the beginning and builds up to a conclusion (the end), this approach starts with a representation of the total process (the end), and allow the student to work back to whichever beginning is appropriate to them.

Structure of the Content

Given the arguments in the previous section, it was natural that the animation of the muscle contraction process was the starting point for student interaction.

The first level of interaction is observation., where the student can observe and manipulate the animation by using the standard QuickTime movie controller. Moving the mouse over parts of the animation identifies components and students can observe how the components interact with each other.

The second level of interaction is *interrogation*. When satisfied with observing the process, students may wish to inquire further into individual components. They may choose one component and find out about its role and interactions, or they might choose an interaction or event and see how each component contributes.

In designing the second level content an effort was made to ensure that it was not textual, linear and didactic. A related design criterion was not to impose the designers' learning behaviours on the users of the program. Instead, an attempt was made to approximate real tutor-student interaction, as identified in Laurillard's [Laurillard 1994] Ideal Teaching Learning Process. This was achieved by analysing the questions which students typically asked of lecturers and tutors, and using these questions as the means by which the students interrogated the information. These ten *questions* are shown in [Tab. 1].

Analysis of the content also indicated that there were eight independent *topics*, corresponding to components of the animation [Tab. 1], and the ten questions could be asked of each of the eight topics. There were thus eighty nodes of information, in addition to the basic description of each topic.

The underlying structure of the content could therefore be modelled by a concentric structure, as shown in [Fig. 2]. Each topic is described by a wheel, with the basic description of the topic along the axis, and questions at the rim.

	Questions	
What is it made of?	Where does it come from?	How big is it?
What does it do?	Where is it made?	How does it work?
What does it interact with?	Where does it work?	Why do you need it?
What controls its activity?		
	Topics	
Thick Myofilaments	Myosin	Troponin
Thin Myofilaments	Actin	Ca^{2+}
	Tropomyosin	ATP/ADP

Table 1: Basic subject components of the Sarco*motion* program

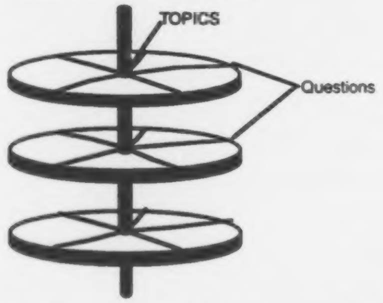

Figure 2: The concentric information structure which can be used to model the content of the SarcoMotion program.

User Interface Issues

[Cooper 1995, Chapter 5] distinguishes three types of user interface paradigms: the "technology paradigm", the "metaphor paradigm" and the "idiomatic paradigm". The technology paradigm is based on the way the program is constructed, rather than on what the user wants to get out of it. Almost all old computer programs had such a user interface. In the IMM sense, if the content had a hierarchical structure with topics and sub-topics, it would be implemented as a series of menus leading to content screens.

The metaphor paradigm attempts to display the interface in terms of some recognised, real-world, visual representation (e.g. the Trashcan on the Macintosh). However, the use of metaphors often restricts the design of the interface, because desired functions are forced into certain forms in order to fit the metaphor. As [Cooper 1995, p54] says: "Most metaphors firmly nail our conceptual feet to the ground, forever limiting the power of our software".

The idiomatic paradigm is based on learning how to accomplish things. It is a simple representation of what the program is to achieve, which users can learn naturally. The idiomatic paradigm is not based on any real construct, but rather on a convenient representation which suits the purpose. A simple example is a window close box.

In SarcoMotion, the animation of the muscle contraction process is the idiom of the user interface. The animation is a visualisation of the entire process, and students are familiar with it, having seen it projected in lectures. Users interact directly with the moving representation of the process, rather than by externally imposed menus or metaphors. The observation level (Level 1) *is* the idiom.

The interrogation level (Level 2) can be easily reached by simply clicking on the moving animation. Depending on which component the user clicked on, the user navigates to the basic information on that topic. That is, to one of the eight nodes shown schematically on the axis of [Fig. 2].

However, once within the level 2 structure, a separate user interface mechanism was required to move between the information nodes. This part of the user interface design occupied most of the time of the design team.

A further criterion in designing the level 2 information was that context be maintained with the animation while the learners browsed to other parts of the second-level information structure. A related decision was that students should have access to the full range of questions and topics at any time in level 2.

A particular advantage of this design is that students can access any piece of information in the program with two mouse clicks: one to go from the animation to the axis of the information wheel in [Fig. 2]; and another to move from the axis to the circumference.

Navigation through the material is natural and direct. To explore a topic, users click on the object in the animation; to explore a question, users click on the question. Because users are interacting directly with the content, by clicking on the object they are investigating, they are creating a cognitive anchor by which to remember the information, and knowledge acquisition is likely to be higher. This approach can be contrasted to the common approach where navigation is by contrivances such as arrows and buttons with names such as 'menu'.

The concentric information structure allows hyperlinks between nodes in a way whereby students are less likely to get lost in hyperspace.

While the points above indicate some theoretical advantages to the chosen design, it was by no means a simple task to actually implement a user interface which encompassed all of the design decisions made. Several prototypes were developed, tested and improved before the final design was agreed on.

Evolution of the User Interface

Version 1

An initial prototype was used to determine the feasibility of the idea of clicking on the animation. In an ideal situation, clickable hot spots would have to be created for all components of the complex animation, for each of the 70 frames. This was not practically feasible. Instead, when users stopped moving through the animation to investigate, it jumped to one of six key-frames, which were essentially still images on which hot spots could be placed.

Testing of the first prototype was done by peer review within the development team.

Clicking on a hot spot took the user to a new screen, as shown in [Fig. 3] of the electronic version of this paper, with one whole screen per information node. While a shadow was used to give an appearance that this screen 'sat' in front of the animation screen, no part of the animation was visible. The only context available to the learner was the image at the bottom right, which showed the part of the animation which had been clicked on. Students could move through the second level information space, learning about individual components, without returning to the animation to obtain an understanding of the process as a whole. This user interface clearly did not satisfy the educational goals of the project.

In designing a mechanism whereby students could access the ten questions, the design team sought to avoid a situation where students could sequentially work through the questions. The questions were divided into 4 categories (what, where, how, why) and displayed with a 'spinning top' idiom, shown at the bottom left of the electronic [Fig. 3]. On entering a level 2 screen from the animation a random choice of question was made by spinning the 'top'. This mechanism appeared to be successful.

Students could only get to another topic by returning to the animation, or occasionally by clicking on hypertext links.

As more content was developed to put into this interface, it was found that some answers to some questions could be answered very briefly, and a full screen was too large for the small amount of information. There were also technical problems with creating hotspots: the number of invisible objects required would have been very tedious to create, and would have severely impacted on the performance of the authoring environment used.

Version 2

A solution for the hotspot problem was achieved in the second prototype by developing a customised external command which identified the colour of a pixel on the screen and used a small database to find which topic corresponded to which colour.

An attempt was made to resolve the lack of context to the animation by using smaller content screens overlaid directly on top of animation. To avoid the problem of varying length answers to questions, all answers for a given topic were combined into one screen which could be scrolled like a world-wide web page. The 'spinning top' idea was rejected, and all topics and questions were visible at all times at the top of the content window, with scrolling content below it. A representative level 2 information screen from the second prototype is shown in the electronic [Fig. 4].

An advantage of having all questions and topics available at all times was that an extra dimension of navigation was possible. In Version 1 (neglecting hypertext links), the only way to get to another topic was to return to the animation (equivalent to returning to and moving along the axis of [Fig. 2]), and then choose another topic (moving to another 'wheel'). In version 2, in addition to moving around the wheel to other questions, it was also possible to navigate perpendicularly, from a question on one wheel, to the same question on another wheel.

Version 2 was tested in normal classroom use and formatively evaluated by student questionnaires and by observation of student use of the program by members of the development team. Some significant problems were found:

- Because the second level content directly overlaid the animation, users thought that the content was the main part of the program, and the animation was secondary.
- Having all the topic and questions continually visible made them behave exactly like menus, and students tended to move linearly through the topics and questions.
- Despite our initial intentions, there was too much text on screen. This was caused by combining answers from all the questions for a given topic into a single scrolling field. Also, more graphics needed to be developed to complement the text.
- Some technical problems with the implementation meant that different parts of the information screen behaved differently at different times. Mouse clicking was not consistent. The mechanism for scrolling through the text by dragging with the mouse was not intuitive, and also clumsy to use.

The design team met again and tried to resolve these problems.

Version 3

The first decision made was to once again separate content into screens with one topic/question per screen. The content screens could thus be made even smaller. The second decision was to offset the content screen from the animation, so that the main animation is always visible, as shown in the electronic [Fig. 5].

The fact that the animation window is always visible behind the level 2 information means that the student can always see where they are and where the topic fits into the context of the whole process.

The ability to choose any question or any topic from a given screen was retained. However, the topics and questions were now hidden in popup menus, in an effort to prevent students moving linearly through the material. The spinning top from version 1 was also reinstated in a modified form. Students could use the spinning top to randomly choose a question.

The level two content also contains links to glossary information, shown in the electronic [Fig. 5] by the underlined G-actin. Topics are also linked where relevant by hot words such as 'thin myofilaments' in [Fig. 5]. Clicking on a hot word takes the user from the node to the appropriate topic on the axis of the concentric structure.

There is thus a very rich navigational structure, with formal links in two dimensions (horizontally and vertically in [Fig. 2]), and hot links where relevant between topics. However, the navigation is achieved by direct interaction with the content, without recourse to artificial constructs, such as navigation buttons.

A further advantage of the concentric content structure and the navigation scheme used in version three was that it is possible to get to every piece of content in level 1 and level 2 with two mouse clicks.

The user interface used in version three was observed to run very effectively with students in their normal classroom situation.

Conclusion

The design decisions made in developing this project were specifically aimed at producing a learner-centred, constructivist learning environment. After the design decisions had been made in principle, considerable effort had to be made to produce a user interface which met the design guidelines, while at the same time providing an intuitive experience for the student. It would have been impossible to arrive at the final product without developing and formatively evaluating a series of prototypes.

The next phase of the project is a formal summative evaluation of its educational effectiveness to be conducted in 1997.

Acknowledgments

The authors wish to thank Angela DiGiorgio for her graphic design work in this project, in particular for her creation of the animation of the muscle contraction process. The Sarco*motion* program was developed using Allegiant SuperCard 2.5. The animation was developed using Macromedia Director 4.0, and saved as a QuickTime movie for manipulation.

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Animation of the Great Hall of the Austrian National Library

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Abstract: This paper describes the process of making an animation of the Great Hall of the Austrian National Library in its current and a reconstructed historical state. This animation was created at the Institute for HyperMedia Systems of Joanneum Research, Graz, based on a digital three-dimensional model, which was built by the Institute for Computer Graphics of Graz University of Technology. After description of the modeling process, we take a look at the various steps involved in building the animation: from definition of motion paths, lighting scenery, to rendering issues and image post processing, which prepared the data for recording onto a CD-I. Finally we describe the adaption of the 3D model for an interactive walk-through as done at the IICM of Graz University of Technology.

1 Introduction

The Great Hall of the Austrian National Library, located in Vienna, is a famous baroque building, designed by the architect Johann Bernhard Fischer von Erlach and his son Emanuel. It was built in the years 1723–1726. In the center of the hall, a larger than life-sized marble statue of Emperor Karl VI. honours the patron of the building. The entire hall is 77 by 28 meters in size, and the impressive oval dome with frescos by Daniel Gran gives the building a total height of almost 30 meters. The book shelves along the walls hold over 200 thousand volumes (mainly from the 16th and 17th century) of the total 6.7 millions of books, papyri, letters, and carthographic material of the National Library.

Under order of the Austrian National Library, the entire Great Hall including the statue was modeled geometrically and photographed to create a computer model whith photorealistic texture mappings. The model of the Great Hall consists of about 68000 vertices, 19000 faces, and 170 texture images. The modeled statue has additionally about 7000 vertices and 12000 faces.

The advantage of creating computer animations of the scene over an ordinary video film is the possibility to create a realistic view of the historical state of the Great Hall, without the columns and arches built later for statical reasons, just as if it still existed today. Thus an effective visual comparison between the historical and the current state is possible via blending the two models one into the other. Moreover the virtual camera allowed extreme views which would have been difficult to realize with a film camera.

Of course realistic rendering of the model was very crucial, however it was decided to make the computer generated data set visible at some places by means of wireframe animations—and also still images as background for menu screens—in order to emphasize the fact that the animation was computer-generated.

2 Modeling the Great Hall

The modeling was done at the ICG (Institute for Computer Graphics and Vision) of Graz University of Technology.

The base material for building the CAD model of the Great Hall consisted of architectural plans, historical maps and drawings, photographs, and manually measured distances. Characteristical for the baroque building is the large number of architectural details, all of which had to be modeled. The original

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CAD model was created with the "AutoCad" software package and then transferred to the Model Editor "Medit" for further manipulation. A wireframe drawing of the CAD model can be seen in [Fig. 1].

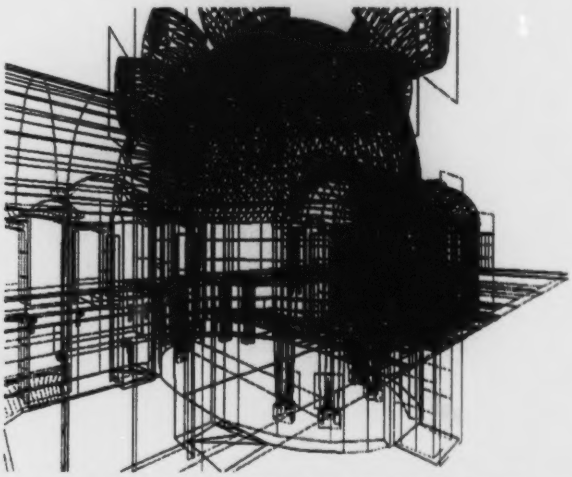

Figure 1: Model of the Great Hall (Wireframe)

170 photographs were taken especially for the purpose of texture mapping. The film was scanned at 1250 dpi resolution. Given the scale of the photographs in range 1:300 and 1:500, this led to a pixel accuracy of less than 1 cm. The sampling of the images to resolution 512 x 512 and 1024 x 1024 preserved a pixel resolution of about 2 cm. A color correction was necessary to compensate the different lighting conditions under which the single images were taken.

To map phototexture onto the geometry, image processing steps were necessary to ensure correspondence of the texture map and the underlying geometry. This had to be done to avoid distortion effects, using software tools created at the ICG. After fitting the images to faces of the CAD model, the images had to be corrected to fit well together where they touched each other. See [Gruber et al., 1995] for more details about this process. This is obvious in the dome which consists of 11 texture images that must match to each other without visible seams.

The reconstruction of the historical state was made based on historical maps and drawings. Missing textures had to be substituted with photographs of similar objects. [Fig. 2] shows two rendered images of the historical and current state of the Great Hall.

2.1 Modeling the Statue of Emperor Karl VI.

The marble statue of Emperor Karl VI. in the center of the Great Hall was modeled using photogrammetric techniques. Images taken from measured positions including reference points were the base for calculating a set of 7000 vertices. The position of these points in 3D space was accurate with a tolerance of only 2 mm. The points were then connected with a set of over 12000 triangles to define the surface of the statue. Manual correction of the automatically generated triangle set was done.

Six of the 20 photographs were then used as texture images. Correction of mapping onto geometry as well as fitting them together, including color correction (mainly equalizing brightness) was done the same way as for the Great Hall. [Fig. 3] shows the statue of Karl VI. as wireframe model and as textured object.

3 Creating the Animation

The animations were created at HMS/IICM with the software package "Wavefront Advanced Visualizer" [Wavefront Technologies, 1991]. After taking over the CAD model of the Great Hall and the Emperor

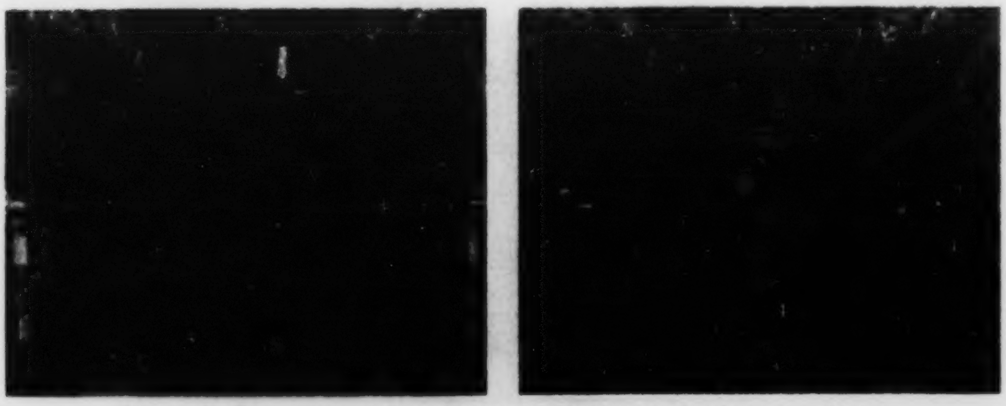

Figure 2: Comparison of Great Hall, before (left) and after Alteration (right)

Karl VI. from the ICG, and some additional processing steps on the geometry the main point is to define appropriate camera paths and a lighting model. Finally the rendered images were prepared ready for recording onto a CD-I, and MPEG movies have been created for viewing the scenes.

For transfering the geometry data from the ICG, we chose the Inventor format [Wernecke, 1994], which can be written by Medit and easily converted to the Wavefront object file format with tools written at IICM. Postprocessing steps like welding of identical vertices and generation of vertex normal vectors could be done via Wavefront command scripts. The geometry model was handled with the "Model" program, surface properties (colors, textures) were defined with "Property".

For the wireframe animation sequences the geometry model had to be reduced in its complexity to emphasize the geometry and to avoid the image being cluttered with lines. The main part of this work was done manually by substitution of geometry with simpler parts, stressing the outlines. To some extent tools for simplifying the geometry automatically could be used: one function merges adjacent triangles into rectangles (used in the dome), another one merges adjacent polygons with an angular variation unter a given threshold to simplify curvatures.

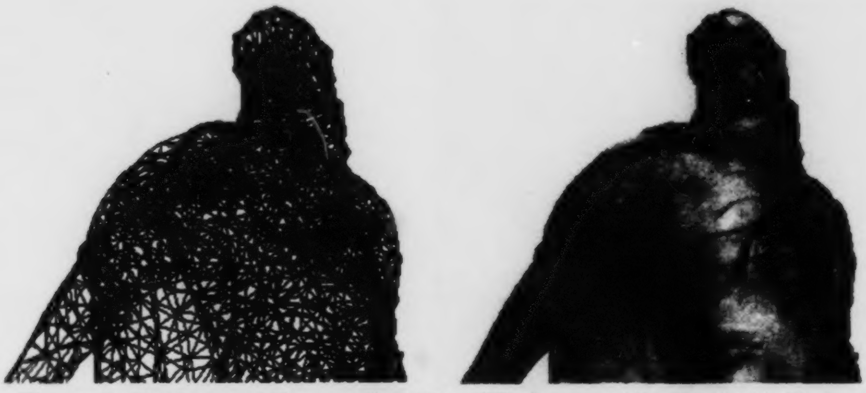

Figure 3: The Statue of Emperor Karl VI. as Wireframe and Rendered with Textures

Placing the single geometry models all together in one scene and creation of animation was done with the "PreView" program of "Wavefront". The definition of camera motion paths and positioning of light sources was also done with this program.

The camera motions of the animations were designed by a director to fulfill several purposes: giving

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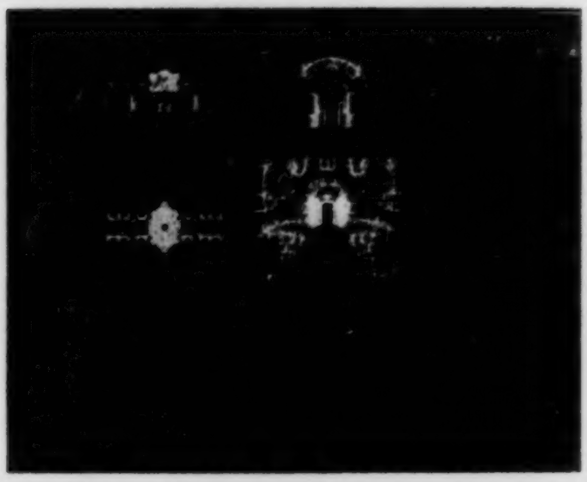

Figure 4: Defining an Animation through the Great Hall (Working View)

an overview of the architectural structure, giving views how the emperor saw the building with his eyes, zooming into interesting fresco details, and, last but not least, comparing the current state of the hall with the original, historical state. [Fig. 4] shows creation of an animation by defining the motion path in "PreView".

For the National Library 11 full-textured animations with a total length of 5216 frames (that corresponds to 3 1/2 minutes of continuous motion) were created, along with 2 wireframe sequences with 315 frames. Test renderings of single images are possible at any time for controlling the lighting scenery and image clipping, whereas rendering of whole animation sequences was done with batch jobs calling the "Image" program. [Fig. 5] shows the playback of an MPEG-movie of an animation sequence. The player shown here includes a software MPEG decoder, real-time check of the motion sequences was possible on a PC with hardware MPEG decoder.

Figure 5: Viewing a Final Animation of the Great Hall (MPEG Movie)

The wireframe images [Fig. 1] required an additional anti-aliasing step [Foley et al., 1990]. The quality

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of the standard output had severe aliasing and the line width could not be controlled, so rendering was done in Wavefront's plot-format instead. These files were rasterized in a larger resolution and multiple line width (with tools written at the IICM) and then scaled down to the final size. Several tests showed a factor of 2.5 times width and height to be appropriate.

3.1 Technical Data

As mentioned earlier, the amount of data that had to be handled was quite large, to achieve the desired degree of realism. The model of the Great Hall consists of about 19000 faces and the statue of Emperor Karl of about 12000. The texture images were processed at a resolution of 512 x 512 in general, using 1024 x 1024 or 2048 x 2048 in sensible areas like for the statue and in the dome. The total memory demand for storing just the texture images is about 100 MB.

All frames of the animation were rendered in PAL resolution (720 x 576) to allow also for the production of a video with 25 frames per second. Each single rendered image took about 1 to 1.2 MB storage caused by the detailed contents. That results in about 600 MB image data for a 20 second motion sequence (500 images). For comparison: a movie in MPEG format and reduced resolution (352 x 288) of such a scene could be compressed down to 3 MB.

It took about 5 to 10 minutes to render one single image on the SGI Onyx (12 to 20 on an older machine used previously), meaning the ability to render 3 to 5 seconds of an animation per day. The computation time largely depends on the complexity of the scene (whether the statue was rendered in it, number of visible polygons). For test purposes (defining the motion path and controlling image clipping) sequences were rendered in lower resolution and quality (no anti-aliasing and filtering, smaller texture images), which took about 1 or 2 minutes per frame.

The shadows visible on the floor tiles were created by applying them onto the floor texture instead of rendering parameters. A realistic lighting model would require radiosity methods, ray-tracing can only give approximations. However such techniques are too computationally intensive to be applied for the amount of data that was dealt with. Reflections were already part of the phototextures and thus were not necessary to create on rendering. For generating a motion blur effect in one of the animations, three times more images were rendered for this scene and composed (averaged) afterwards.

4 Interactivity

Whereas the final movies of the animation sequences can be viewed on many machine types in high quality (like CD-I players or Multimedia PCs), they restrict the viewer to follow a predefined path through the model. These paths were created carefully to emphasize architectural details of the building and to interpret views of the emperor.

On the other hand users wish to overcome the limitation of a predefined motion, and wish to explore the building in a personal way. The 3D computer model offers the possibility to walk interactively through the architectural model.

Thanks to VRML, the Virtual Reality Modeling Language [Pesce, 1995], a common file format for describing 3D scenes on the net, it is possible to offer 3D computer models on the WorldWideWeb or with Hyper-G, which can be viewed on a variety of platforms. One such VRML viewer, VRweb [Pichler et al., 1995], is developed at the IICM.

Obviously, an interactive walk-through in real-time (at least 10 to 20 frames per second) cannot offer the same image quality as the prerendered images of the animation (which took up to 10 minutes per image to render). Only high-end platforms (e.g. SGI Onyx [Akeley, 1993]) allow interactive navigation in real-time in acceptable quality, even on a model with less detailed geometry. [Fig. 6] shows an interactive walkthrough through the VRML model of the Great Hall, displayed with VRweb.

The CD-I technology chosen for this project made it possible to present the full detail of the photorealistic rendered animations, still allowing interactive navigation by means of menus and cross linked data sets, where the animation sequences are embedded into a trilogy of CD-I's representing the construction, history, and present of the National Library by means of text, images, sound, video, and animations.

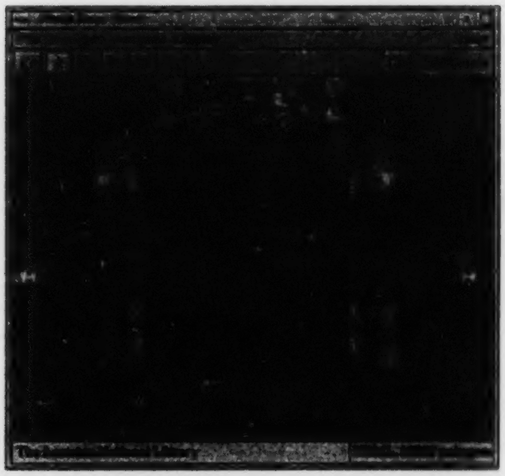

Figure 6: A Textured VRML Model of the Great Great Hall

5 Conclusions

Creating animations of the Great Hall of the Austrian National Library with a high degree of realism required a detailed model, high quality textures, and sophisticated modeling and rendering techniques. The individual steps for creating the model and building the animation were discussed. The model and the animations serve as a documentation of the baroque architectural highlight.

The technological progress allows more and more larger models to be rendered with even better techniques like recursive ray-tracing and radiosity etc. for realistic light and shadow effects. On the other hand, the demand for interactive views of large, realistic 3D models, where users are not restricted to predefined camera motion paths, is increasing. The experiences obtained on building the model and the animation will form the basis of further investigations in this area.

We want to thank all people involved into this project at ICG, HMS, and IICM. Further thanks go to all cooperative people at the National Library and Houdek & Kurek.

Parts of the project documentation, a few sample animations and images, as well as 3D models in VRML format, are available online at `http://www.iicm.edu/natlib/`.

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Distance Learning in Multimedia-Networks: a Finnish National Multimedia Project

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Abstract. This paper discusses a project called Distance Learning in Multimedia-Networks, a part of the Finnish National Multimedia Programme. The project started on the 1st of February, 1996 and it joins the efforts of Finnish telecommunication companies, content providers, publishing houses, hardware companies and educational institutions to develop open and distance learning. In this paper the project's background, development and research work, the project's organisation and essential results during project's first year are presented and future developments are outlined.

1 Introduction

The Finnish Multimedia Programme (FMP) (*http://www-tre.research.nokia.com/*) supports the Finnish communication, media and telecommunication industry and improves the field's international competitiveness in the area of telecommunication and terminal technologies, and in developing and taking into use of new infrastructures, in research and development and in producing contents and services for multimedia networks. The Distance Learning in Multimedia-Networks project (*http://matwww.ee.tut.fi/kamu/*) that belongs to the Finnish Multimedia Programme joins the field's technical and pedagogical research centres and institutions that provide distance learning, hardware, software and content producers and telecommunication enterprises in an extensive joint project. The budget of the project is approximately 2 million Finnish marks per year (400 000 USD). The aim of the project is to develop technically and pedagogically useful methods for distance learning that utilise networks and multimedia. Development of fast networks (e.g. ATM) makes it possible to carry out real time and interactive distance learning. Teachers and students, courseware and departments may be geographically situated in different units. Tele-teaching may involve classes, personal computers or workstations and teacher and student can communicate via the network. [see Pohjolainen & Ruokamo-Saari.]

Hypermedia courses will be constructed to be used on a computer - these courses support spontaneous, experimental way of study. WWW-type of platform independence makes it possible to utilise hypermedia-based courseware anywhere Internet is available. Personal computers with multimedia properties are effective in processing and receiving information in the form of text, sound and video signals. Multimedia in distance learning has an essential role in the European Union's 4th stage research programme, especially in the telematics programme. Telepresence and learning environments or microworlds in education has risen to be an internationally important field of research and development. Distance learning using multimedia is exploited by schools, educational institutions, adult learning, private students and enterprises.

2 Project's Development and Research Work

In the Distance Learning in Multimedia-Networks project learning environments are studied and developed from three points of view; telecommunications (hardware), hypermedia (courseware) and pedagogical. The structure of the learning environments is designed to be suitable for different learning situations and for the use of different media as well. In addition to this methods and tools are developed (software) to easily work up and convert existing material (e.g., text, pictures, animation, video) to be used in a learning environment. Students can communicate with the teacher, enrol for courses, receive personal guidance and feedback, pass examinations and receive results.

The usability of the learning environments is developed in various kinds of learning situations in different kinds of transmission and reception environments. Testing is made with various kinds of participants in connection with pilots that are put into practice during the project. Feedback from pilot experiments is used for further development of learning environments.

2.1 Designing of the Learning Environment

2.1.1 The Learning Environment

Designing the learning environment takes into account mental, physical, and social functionality and different kinds of learning materials, media, and technological solutions as parts of them. The quality of video and audio are important factors as a part of media, the option for taking into use multiple channels (video camera pictures) at the same time and transmitting distance learning in a technologically easy way. Teacher's and student's telepresence should be as good as possible and the environment should make it possible to realise interaction between teacher and student easily. Using available fast ATM-network connections and real time video links, learning environments are considered from different transmitting environments , such as

- teacher's workstation
- traditional classroom
- lecture room
- seminar room
- distance learning studio

to different reception environments, such as

- classroom
- lecture/exercise/seminar room
- computer classroom
- single workstation/computer

Student's learning environment may be situated at home or in a library as well. On of the aims of the project is to make studying as far as possible independent of time and place by creating various functional learning environments.

2.1.2 Hypermedia-Based Learning Material

Computers can be used in many ways to support learning in multimedia-based learning environments. In addition to real time videoconferencing hypermedia-based learning material can be used in a computer. With the hypertext's linking properties words/files/formulas/pictures can be linked with the text. The basis of linking that supports studying is the determination of the document's structure. [see Pohjolainen, Multisilta, Antchev.]

The structure of the hypermedia documents is designed on the basis of SGML/HTML. Text is divided into structural parts and linking that supports studying is designed. During the project the necessary software will be produced, with which learning materials can be converted to be suitable for network. Also it will be designed how videos, graphics and animation will be attached to the text-based material. And, in special, it will be studied how the existing video servers can be joined to hypermedia learning environment.

2.1.3 Information Systems and User Interface

Management routines of the studies will be connected to multimedia environment. Via the network students can

- receive information about their studies and enrol for their courses
- communicate with other students and the teachers and get feedback
- take examinations (in the future)

Multimedia-based distance learning, teacher's and student's telematic interaction and hypermedia courseware will be connected in a pedagogically appropriate manner to a learning environment.

2.2 Distance Learning Experiments

The purpose of the distance learning experiments is to test both the technical and pedagogical functionality of the distance learning solutions developed.

The Digital Media Institute at Tampere University of Technology has a fast network connection (ATM) to Kaukajärvi school [see Koskelainen et al. 1996a, 1996b] and to some other educational institutions and to the student dormitory of Student Housing Foundation in Tampere. This environment is used for ATM-based distance learning via multimedia networks. In Kaukajärvi school the first teaching experiments using ATM-connections during spring 1996 have already been made [see Ruokamo-Saari 1996a, 1996b] and in autumn a teaching experiment in Russian language has started [see Puuskari & Suvanto]. Experimental university level teaching between Tampere University of Technology and University of Jyväskylä using fast ATM-based network will begin in the spring 1997.

Adult education will be arranged via open universities that already are familiar with adult education. The contents of adult education are e.g.: mathematics, communications, education, languages. Network solutions are based on Internet, for which student services and counselling that supports interactive private study, is being designed as a part of the project.

Adult education is also arranged as internal education of enterprises. In this project an experiment is carried out with NOKIA/NTC. The purpose is to provide hypermedia based studying material for company's new employees.

3 Preliminary Measures and the Organisation the Project

In the beginning of the project in spring 1996 the following adjustments and mappings have been made:

- Preliminary selections of learning materials and contents has been done taking into account the available teaching experiments in the near future.
- The general structure of hypermedia learning materials has been outlined as well as the possible problems in its production. The media and video servers' potential utilisation has been considered.
- Technical mapping of distance learning has been done.
- Mapping of the interests of the enterprises has been done.

The general plan was prepared in a brainstorming session on 21 May, 1996. In that session there were over 50 participants interested in the field. The results of the session were presented in a multimedia seminar, held later in spring, and the plan was focused on 6th of July at the meeting of the management group.

The organisation of the Distance Learning in Multimedia-Networks project is presented in Figure 1. A management group and supporting group of the project's management has been chosen. ***The supporting group*** is composed of persons from research units that are responsible for the project. ***The research teams*** are divided into three: ***1. Network and technical experimentation, 2. Hypermedia material production*** and ***3. Methods of distance learning*** teams. The research teams consist of researchers on the project. The ***pilots*** participants are both project' researchers and representatives of enterprises and educational institutions. The pilots are divided into the following groups: 1. Fast networks and technical experiments, 2. Natural sciences, 3. Languages, 4. Education, 5. Communication and 6. Enterprise education.

ORGANISATION

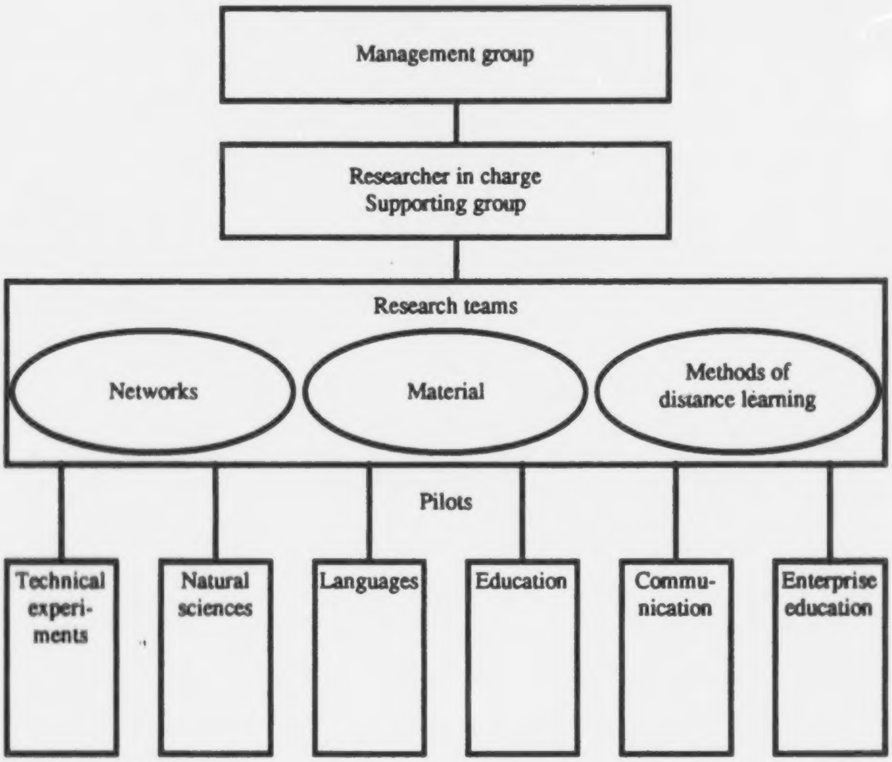
Management group
Researcher in charge
Supporting group
Research teams
Networks
Material
Methods of distance learning
Pilots
Technical experi-ments
Natural sciences
Languages
Education
Commu-nication
Enterprise education

Figure 1. The organisation of the Distance Learning in Multimedia-Networks project

4 Conclusions

In this paper a national Finnish project on open and distance learning has been presented. The major goal of the project: the design of an open learning environment from both the technical and pedagogic points of view, as well as the various distance learning experiments that has been put into practice in order to obtain feedback from the various solutions, have been discussed.

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Children Learning Filmmaking Using Multimedia Tools

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Abstract: Children watch lots of TV and movies, but they rarely make films. This is because the production process is complex, the result is hard to visualize, and one must use and integrate textual, audio, graphic, and video media. Computer-based multimedia facilitates idea development and visualization, and affords the integrated handling of multiple media, so it should aid movie creation and production.

This paper reports on the use of our Movie Authoring and Design (MAD) multimedia system in a summer camp. We wanted to test if this system and the process of motion picture creation could be quickly learned and effectively used by school children. MAD and a control condition of conventional digital editing tools proved to be useful for and usable by eight groups of 3 seventh graders to achieve proficiency and make 2 movies each in the space of a week. The paper presents both quantitative and qualitative data illuminating the children's accomplishments, effects of learning new skills and acquired experience, software and counselor effects, and factors contributing to the success of a novice movie.

Keywords: Multimedia, filmmaking, children making movies, educational software, collaborative learning, empirical studies, qualitative methods, within-subjects experiment.

INTRODUCTION

Children today spend significantly more time watching TV and movies than they do reading. Yet students are not learning to express themselves in the dominant media:

> "The essential medium of expression in the classrooms is no longer print. It's a hybrid of print, video, audio and video games, but unless we provide access to the tools to compose in this medium, we will be training students to be readers but not writers. And if all they do is read these multimedia texts, not only will they have sore eyes, they will be missing out on an important part of what it means to be literate." [Reilly 96]

There is very little literature (but see [Buckingham 90; Paley 95]) describing studies of children creating media. An exception is Reilly [Reilly 94, 96], who documents innovative uses of multimedia authoring at several California high schools as a part of the Apple Classrooms of Tomorrow program. The students create video essays, music videos, and public service announcements, using conventional text editing software and video editing equipment.

Our Movie Authoring and Design (MAD) system [Baecker et al. 96; Baecker et al. 97; Cohen et al. 96, Friedlander et al. 96; Posner et al. 96; Rosenthal and Baecker 94; Rosenthal 95] was designed to assist hierarchical development and organization of movie ideas and components — scripts, pictures, audio, and video, to support their manipulation in a unified manner that is easy to learn and use, and to aid visualization of the ultimate result. It can therefore assist both experienced and novice movie makers, and has been successfully used by children as young as 11 years old.

We believe, as does Reilly, that children benefit by being able to express their ideas in movies, and that digital media can provide rapid learning opportunities and access to filmmaking tools previously reserved for experts. We wanted to study and test these hypotheses in a controlled but realistic setting. We also believe that the idea development, organizational structuring, and visualization capabilities of MAD provides benefits above and beyond those present in conventional consumer digital video editing. We therefore decided to study children's usage of MAD compared to "conventional" digital editing software.

Our report begins with a description of the capabilities and uses of MAD. We then describe the study setting, hypotheses, and experimental method and data sources. A summary of results presents effects of group work, acquisition of new skills, movie quality, effects of software and counselors, and determinants of success. A more complete discussion of the results may be found the companion paper included in the CD ROM [Posner et al. 96, 97].

SOFTWARE FOR MOVIE AUTHORING

MAD is the first system that allows the design and management of words, images, sounds, and video for visualization during the pre-production and production phases of a motion picture. Key design goals were:

- *Hierarchic idea structuring* — the ability to develop movie ideas both top-down and bottom-up, to modify the structure with ease as new ideas arise, and to work at whatever level of detail is desired.
- *Multimedia support* — the integrated handling of scripts [Figure. 1], dialogue or narration, music, sound effects, storyboards, and video shots, and of commentaries on these elements, all tied to the hierarchic film structure.
- *Visualization* — the inclusion of aids to visualizing the film, as for example being able to request a real-time preview of the movie or an approximation to it at any stage in the film development process.

MAD differs from other pre-production filmmaking tools such as script writing software by including multimedia support and visualization capabilities. It differs from other multimedia authoring tools in providing stronger support for film narrative and dialogue structure [Baecker et al. 96].

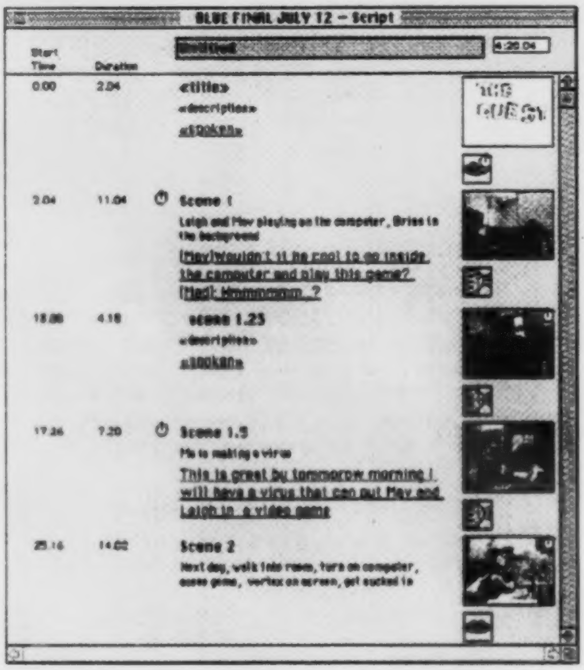

Figure 1: MAD's script view. Timing information is in the left column. The central area displays script details — scenes and shots, director's notes, narration and dialogue. The right column indicates the video and audio components of the movie, as well as annotations. This example is from the movie *Quest* produced at our camp.

MAD is a versatile tool that can be used for many different purposes including:

- Sketching, designing, thinking about, blueprinting, authoring motion pictures
- Developing, presenting, and selling film, video, advertising, and multimedia concepts
- Brainstorming, planning, structuring, and executing lecture-demonstrations and multimedia presentations
- Kids making films; Teaching filmmaking to novices; novices learning filmmaking
- Facilitating reflection on and dialogue about classroom practices by students and teachers [Cohen et al. 96]
- Multimedia messaging over the Internet.

THE STUDY AND THE HYPOTHESES

Our work is a study of filmmaking using multimedia tools in a multimedia summer camp for 7th graders. As movie production is typically collaborative [Gidney et al. 94], we divided campers into groups so that they could share ideas and the work. We used high school students as counselors and technical support staff to provide guidance and technical support. In our pilot pre-camp we discovered that children could complete a movie with MAD or with the control software in under two days. This allowed us to design a within-subjects study in which each group would make one movie with MAD and another one with the control software.

We hypothesized that children would learn quickly to make movies using digital filmmaking software. In particular, we hypothesized that MAD would prove to be both useful and usable for this task.

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With respect to conventional consumer digital editing software, we felt that filmmakers using MAD could work faster and would experiment with more variations of their movies. Because using MAD should allow authors to focus on the high level structure of their movies at all stages of the creative process, we believed that this should lead to better movies. Finally, we hypothesized that users should have positive attitudes towards the software and show preferences for MAD over the conventional consumer digital movie editing software.

METHOD

Hardware and Software

The Multimedia Summer Camp was run at a new multimedia laboratory at the University of Toronto Schools (UTS), a school known for excellence. The lab was equipped with networked personal computers and camcorders.

The experimental software was MAD 2.4 running on Macintoshes with system 7.5 and Quicktime 2.0. For the control condition, we attempted to simulate "conventional video editing" with two VCRs by using software [QuickMooV 95], which provides minimal functionality of selection, cutting, and pasting of digitized video segments. Both software conditions had to digitize their analog video from the camcorders to the computers, using Apple Video Player [Apple 95], and to compress large video files, to maximize usable disk space.

Participants

Counselors and support staff consisted of six high school students. The four counselors were 2 males and 2 females, 2 grade 11 and 2 grade 13 students. The technical support staff were male grade 11 students with extensive computer experience. All staff went through a pre-camp, where they were able to use the software to make their own movies, and then to supervise groups of campers, grade 7 students from their own school, to give them experience with this type of counseling.

The campers were 24 grade 7 students who were selected randomly from 230 applicants, 9 females and 15 males (one female was unable to attend due to illness). All applicants were 12 and 13 year old students from a suburban Toronto school district. Their computer experience varied from no experience at all to 9 years of computer usage.

Camp Process

The camp was run for two weeks. Twelve campers attended each week — 5.5 hours per day for 5 days. The campers were divided into four groups; we controlled for computer experience and gender, and tried to ensure that group members were from different schools.

Each group was assigned a counselor and a software condition for making their first movie, which was to be a movie about themselves. All groups were given a brief talk about moviemaking and a demo of the software. They were then allowed to work on their movies at their own pace under the guidance of their counselor. The groups spent between 5 and 9 hours working on their first movies.

After the completion of the first movie, there was a showing of all films, followed with a lecture by a professional movie maker on various aspects of his work. This talk included a discussion of some of the problems that were encountered in the first movies — bad sound quality, unimaginative camera work, sloppy editing.

Next, our original groups of campers were assigned a new counselor and new software for making their second film, on a topic of their own choice. Another demonstration of the new software was conducted. The groups spent between 5 and 11 hours working on their second movies. On the last day of camp there was an awards ceremony with prizes. Every camper could take home a VHS copy of their work to show family and friends.

We also included Internet surfing and computer games to enliven and enrich the campers' breaks.

DATA COLLECTION AND MEASURES

We collected large amounts of data using questionnaires, audio and video journals, digital records, paper artifacts, and group discussions.

Expertise and Accomplishments: A background questionnaire asked about campers' experience with technology (e.g., video games, VCRs, video cameras), computers, moviemaking, other interests, and group work experience. The campers' knowledge of moviemaking was also assessed three times throughout the camp [Posner et al. 96].

After each movie, the campers filled out a questionnaire asking about their experiences with the software and with their group. Post-movie group discussions also addressed campers' experiences and concerns.

Movie Structure: We collected and preserved their paper artifacts including rough notes of brainstorming ideas, storyboards, and scripts. We gathered the original footage filmed by the campers and kept VHS copies of all final films for evaluation and analysis.

All digital records and files were saved (approximately 600Mb/movie); these included scripts, digitized video segments, and versions of the evolving movies. We also analyzed movie and script structure using a detailed quantitative evaluation form [Posner et al. 96].

Movie Quality: The quality of the movies was rated by three "experts" — one movie maker and two avid movie viewers. They used three categories (technical merit, creative ideas, and overall impression) and a five point scale (excellent, very good, good, fair, poor). We used the sum of the ratings of the three experts as the score in each category; for example, the overall scores for the sixteen movies ranged from 3 to 15. The sum of the three categories produced a total score ranging from 12 to 44 (out of 45).

Process: For recording the moviemaking process, the counselors kept records of their groups' work using paper activity calendars and audio journals. We also collected video journals that contain the first two hours of work on each movie, six of which have been analyzed for this paper.

To visualize the process information we plotted the groups' activities by combining details from calendars, audio journal transcripts, observers' notes, and digital time stamps on files according to the following categories: brainstorming, script writing, filming, digitizing and compressing, editing, Internet searching, and miscellaneous.

Preferences: The two post-movie questionnaires asked about the ease of use and enjoyment of the experience with the software. A final questionnaire asked campers to rate and compare the two programs in terms of overall preference and in terms of specific moviemaking activities.

SUMMARY OF RESULTS

This section provides a brief summary of the study results obtained using quantitative and qualitative analysis of data collected of the students' digital filmmaking activities. For a more complete discussion of these results see the accompanying ED-Media/Telemedia '97 CD ROM.

Group Work: Campers learned how to work in a group sharing responsibilities by dividing the moviemaking roles such as writing, directing, acting, and camera work. Some groups rotated campers through the various roles, while others allowed individuals' preferences and strengths to guide the role selection.

Learning Moviemaking: Children's filmmaking imagination and creativity is quite extraordinary, allowing them quick entry into the world of film authorship despite the lack of filmmaking theory, technical skills, or computer background. The highest rated movie with a perfect score of 15 was *Quest* a story about kids being sucked into a video game. The group started with a very detailed MAD script (283 words) outlining their intricate plot and dialogue. Both live action and video games were used, as well as smooth creative transitions in which game characters fade in and out of reality. The soundtrack combined the *Mission Impossible* theme song imported off the Internet, computer game sounds, and audio recordings input via the camcorder or directly into the computer. This 4.3 minute long film contains 41 shots (camp average was 15 shots per movie) and took about 10 hours to complete (average completion time was 7.5 hours).

Learning New Technology: The campers quickly achieved competence in many different and new technologies — Macintosh computers, video cameras, digital editing, digitizing, and specific software.

Instructor: "How was it using that software?"
Camper: "It was the first time for me. I found it pretty good."
Instructor: "Easy, hard?"
Camper: "Kinda hard, but then you catch on and it's easy."

Learning Organization Techniques: Organization skills are extremely important in moviemaking. Some groups improved significantly over time. For example, on their first movie one group spent minimal time scripting and planning. They filmed without rehearsal and without retakes, edited quickly and then moved on to the next part of the movie. The same group was much more professional on their second movie. They spent much time discussing the plot and resolving the details of their story. Point-form notes were expanded into a list of scenes and then into a storyboard depicting 10 scenes. Although the dialogue was not written on paper, the participants improvised and rehearsed their lines, and recorded numerous takes of each scene. They recognized the payoffs from this improved work organization — planning story details, creating a storyboard, filming ordered by location, digitizing in related segments, and editing in one stretch:

Camper : "Acting we did together, then we edited. We did it different from last time when we did a little bit of acting and a little bit of editing. This time we did all the acting together. I like it better with all the acting first because it is easier. "

Movie Quality: The increased experience and exposure to filmmaking concepts resulted in children's second films being more complex technically than their first films (Movie 1 = 6.3, sd = 2.38, Movie 2 = 9.6, sd =2.56) ($\underline{F} = 7.84$, df = 1, 15; $p < .05$). The second films were also judged to be of significantly higher quality (Movie 1 = 6.3, sd = 2.7, Movie 2 = 9.9, sd = 2.9) ($\underline{F} = 7.15$, df = 1, 15; $p < .05$). The children spent more total time working on their second movies than on their first (Movie 1 = 287 min, sd = 56.9, Movie 2 = 364, sd = 64.5) ($\underline{F} = 9.9$, df = 1, 15; $p < .05$) and also did more editing and refining for their second films. .

Software Effects: MAD proved to be both useful and usable, confirming previous studies [Baecker et al. 96]. Software condition did not effect movie quality, however, working with MAD seemed to encourages more editing and refining than working with the control software. Children preferred MAD to the control software; 91% preferred MAD and 9% had no preference. Given a choice of software, the campers would prefer to take MAD home:

> Instructor: "If you had a choice, which one would you take home?"
> Camper 1: "MAD."
> Camper 2: "MAD, because it's better, just better."
> Camper 1: "MAD has more options."
> Camper 3: "You can do more things in MAD."

Counselor Effects: Despite our attempts to balance the influencing factors, counselors had significant effects on group work and movie quality. Counselors contributions to their group's efforts varied from minimal input to extremely controlling influence:

> "Press shift, drag the button, go back, let go ... get rid of this and this too ... fast forward to ..."

The counselors' feedback approaches ranged from excessively positive to constructively critical feedback. Prior experience and attitude of counselor also effected the groups' experience in either a negative direction,

> "We're going to start making the movie. Its going to be a bit tedious ... filming, then editing on the computer."

or in a positive direction,

> "We're going to be using different software. ... Its much better. You can do lots more with it, like include Internet pictures and soundtracks."

The overall movie scores were also related to counselors ($\underline{F} = 4.7$, df = 3, 15; $p < .05$).

Determinants of Success: We looked at the most successful films to see if there were common elements among these movies and among the work processes followed by these groups. Five out of sixteen films scored more than 30 points (out of total 45). The groups working on these top films spent significantly more time in the idea generation and script writing phase (top 5 films = 1.7 hours, other films = 0.8 hours, $t(14)= 3.65$, $p<.001$). The movie quality scores were significantly correlated with the time spent in the idea phase ($r^2=.54$, $p<=.01$). Although there was no significant difference in final movie length, the top five movies had significantly longer scripts (257 words compared to 134 words, $t(14)=2.88$, $p<.05$). And although there was no significant difference in number of scenes, these groups produced more detailed storyboards (4 scenes compared to 1.6 scenes).

Another similarity that was observed among the top five movies is the amount of critical reflection undertaken by these groups. The guest moviemaker suggested that everything in a movie must be done for a reason, every camera angle and motion, every scene change. These groups seemed to follow this advice, they spending much time discussing the details of their movies. Their films seemed better planned, thought out, and more intentional decisions were made than on some of the lower rated films. Their enhanced shared understanding, using scripts and storyboards, and critical evaluation throughout the moviemaking process lead to films of higher quality.

CONCLUSIONS

Our multimedia camp was a success, a worthwhile and rewarding undertaking for 23 seventh graders. All groups successfully completed two movies; campers were proud of their movies and eager to take them home to show to family and friends. Many campers and their parents wanted to know if they could attend our camp again, next year. If this were possible, it would be interesting to see what they could accomplish one year later.

Yet we must temper our enthusiasm with the reality that multimedia camps are very hard to run. Equipment is still expensive and rare in local schools. Significant numbers of video cameras, computers and experienced support personnel are required for smooth function. Technical problems often lead to lost work and frustration with software and hardware.

Discussion and Implications

Given the lack of literature in this area, other thorough studies of moviemaking need to be done. In our next in-depth study of the use of digital filmmaking technology, we would like to change the task duration and the training and support given to the students.

The staff and counselors' background and expertise in filmmaking, hardware, and software had a dramatic effect on the campers' experience. Small amounts of well-timed instruction in the lecture about filmmaking held after the children finished their first movie produced immediate effects, such as an improved variety of camera angles, better sound, and better editing. Although the fact that a relatively inexperienced staff can run such a camp successfully is encouraging in terms of the ability to replicate such as program widely, we are convinced that having a more experienced and better trained staff would have produced a richer learning experience for the campers. To paraphrase [Reilly 96], the teacher has the primary role in the classroom and the technology has the secondary role.

More specifically, it was the case that without close guidance and highly structured instruction, children did not naturally follow the iterative design process and critical appraisal of their movies. We wanted students to go beyond the basic use of the tool to a more sophisticated discipline which involves the careful crafting of various media representations such as script or storyboard, which may involve collaborative work by multiple contributors bringing different skills to the endeavor, and which must involve thoughtful critiquing and iteration upon the result in order to produce the best possible product. This did not happen in our camp as much as we had hoped for.

Rather than trying to do this in a summer camp, it is more important to integrate collaborative multimedia authoring into the school curriculum as a vehicle for expanding students' creativity with projects and assignments in courses such as history and science. This should be done with close supervision and with continual and critical feedback from both teacher and classmates [Reilly 96].

If we can achieve this, we believe that tools such as MAD supported with reasonably straightforward learning materials can enable a powerful and compelling new classroom literacy for telling stories, exploring concepts, and expressing ideas.

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Reducing Distances for Face-to-Face Education

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Abstract: The purpose of this paper is to question the necessity of national programs of distance education in Brazil without considering the reality of the states, with particular reference to Bahia.

The Brazil government has actively promoted distance education projects not always taking into account the local reality and the public higher education system.

Bahia has five public universities spread throughout the state, already working together with many public primary and secondary schools. We are discussing the possibility of linking all sectors of public education, using new technologies of communication, and collectively developing programs to re-design the focus of training courses, undergraduate courses and support public schools and teachers.

Our goal is to create a new pedagogical vision, supported by these new technologies, which, by their very nature, reduce distances, in conjunction with face-to-face education, to transform schools into a place where culture and knowledge are produced and promoted.

Do we really need distance education?

The development of new communication and information technologies is occurring at an overwhelming pace. I use the term communication to refer to mass-media systems such as TV and cable networks, as they are currently structured. The term information refers to computer-based technologies such as Internet, Intranet and on-line services, etc.

All over the world there has been a merging of several once divergent fields, which, until recently, had even been competitors, such as communication, information and entertainment corporations. The English publication *ScreenDigest* shows us an intersting map of this converging media landscape in its Jannaury 1994 issue [ScreenDigest, 1994].

Today's electronic equipment is becoming obsolete very quickly and once separate devices are converging because of the rapid evolution of technology [Gilder, 1996]. According to *ScreenDigest*, since 1992, multimedia "is coming to signify a specific convergent concept in which single carriers deliver a complete audio-visual range" [ScreenDigest, 1994].

Distances shrink due to the myriad of possibilities for communication. In Brazil, academics are discussing whether in fact we are taking full advantage of this world of information, while keeping in mind the great social disparities that exist in our country and in other developing countries.

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According to the 1995 National Household Survey (PNAD - Programa Nacional de Amostragem Domiciliar) carried out by the Brazilian Institute of Geography and Statistics (IBGE) [1], 78% of Brazilian households have televisions, which makes the programming of the large national networks accessible. The most important broadcasting system, whose signals can be tuned in in 99% of Brazilian municipalities, is *Rede Globo*, controlled by the Roberto Marinho family. They control, according to the *Folha de São Paulo*, 60% of the advertising market through their 17 TV stations and associated TV channels. Recently, Rede Globo established an association with the Murdoch Group, thus making it the fifth largest communications conglomerate in the world and they are beginning to operate the DBS TV system in Latin America.

However, this is only one-way communication. True communication requires interactivity with information flowing in two or more directions. The same IBGE survey showed that only 22% of Brazilian households have a telephone line, which is a basic requirement for access to the Internet.

In Brazil, the policies of the current federal administration have been detrimental to public universities by cutting budgets and reducing staff. They have even proposed revoking the policy of free public education which has been in effect since the system was established. The Brazilian public university system is vast and covers the major population centers of all 27 Brazilian states. In the last few years an increase in the number and size of private universities has changed the face of higher education in Brazil.

The new proposal also includes a controversial subject: university autonomy. Represented as an important advantage of a new "democratic" system, the type of autonomy proposed is considered by some within the university as a trap, because outside large urban centers, São Paulo and Rio de Janeiro, the public universities and most individual faculties are not and will never be economically viable.

On the other hand, Brazil is going through difficult times with respect to its institutions of higher education. One can infer from its contradictory movements, pronouncements and projects that the government is putting into practice a plan to suffocate these institutions and is using distance education as possible solution for at least a few of the problems in primary and secondary schools. This discussion, while not a priority subject in Brazilian society as a whole, is going on inside the universities in a very intense manner, due mainly to the government's proposals regarding university autonomy. I do not think it is possible to overcome the backwardness of the educational system without a successful partnership between the public institutions of higher education and the public primary and secondary educational system.

We are experiencing what may be described as a generalized *fever* of distance education projects in an attempt to solve education problems as if it were possible to develop these projects without taking into account all aspects of this complex system.

It is precisely this government, which is providing, in theory, incentives to distance education projects, including the creation of a department specifically for the subject (Secretariat of Distance Education), that has clearly stated its position against maintaining the present public higher education system. This policy, in my opinion, presents an inherent contradiction. In this paper, I intend to discuss and analyse the relationship between distance and face-to-face education with particular reference to current situation in Bahia/Brazil and to illustrate this contradiction.

Distance Education in Brazil: a Quick Overview

In Brazil, there have been numerous initiatives to develop distance education projects. Parallel to the developments in the private sector, since the 1960s, by providing in particular technical courses for specialized training (e.g. the pioneering *Brazilian Universal Institute*) there have been other significant governmental movements in this field worthy of mention.

One of the pioneers in Brazil, the *Saci Project* was implemented experimentally in the State of Rio Grande do Norte in northeastern Brazil at the end of the 1960s without achieving significant results, as Laymert Garcia dos Santos described in his book *Desregulagens* [Santos, 1981]. Other experiments in the field were or are being developed in Brazil, as is the case of the regular courses offered by the Educational TVs of the states of

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[1] see URL: http://www.ibge.gov.br/

Maranhão, Ceará and Amazonas (northeastern and northern Brazil), to meet the needs of the last three grades of primary school [2].

According to Lobo and Leobons [Lobo, 1988] there have been innumerable distance education initiatives dealing with supplementary education and teaching by correspondence. In 1971 the Brazilian Educational Technology Association (ABT) was created. Since 1972, it has maintained advanced training courses for Primary School Certification and published a periodical, *Tecnologia Educacional*, thereby providing a forum for discussion on the topic. As Ligia Leite explains, both the Association and the periodical have undergone name-changes reflecting the evolution of the concept of the relationship between education and communication technologies [Leite, 1992].

The National Institute for Educational Studies and Research (INEP) published a State-of-the-Art report on the matter in 1987 (Bibliografia Especializada em Educação - Educação à Distância), as part of the Latin-American Information and Documentation Network - REDUC, which brings together 23 educational research centers in 17 countries in Latin America and the Caribbean [MEC, 1987].

As stated previously [Pretto, 1996], in 1986, the Education Ministry tried to breathe new life into the *Saci Project* based on the work of an Inter-Ministerial Commission, officially established pursuant to charter n° 390/86, involving both the Education and Communications Ministries, with the aim of studying the "possibility of implementing a basic education system via satellite". The team from the Communications Ministry showed a great deal of interest in providing incentives to use the Brazilian geostationary satellite for educational purposes. What was not clear, however, was pedagogical project which would be the cornerstone of this initiative. The very group that chartered the commission was already showing signs that it was looking to implement a *parallel* educational system with classes being transmitted from Brasília (or Rio de Janeiro) to the rest of Brazil and which would be captured by nearly 30 thousand satellite dishes to be installed in the different Brazilian municipalities [Pretto, 1996]. This meddling by other ministries in education is no novelty. According to Maria Luiza Belloni, this had already occurred when the *Saci Project* was negotiated, when the Education Minister (1970/1974) evidently became irritated with the director of INPE who "invaded without ceremony the dominion reserved for the Ministry of Education and Culture"[Belloni, 1983, p. 176].

When the Commission's work was finished, a generic report was published without any concrete decision on the use of the satellite for educational purposes. Nine years later, the Education Ministry launched its *TV-School project*, also centered on the use of satellites and satellite dishes in the schools, this time to train primary school teachers. Numerous articles are being written or have already been published on the subject and no further detail is necessary here.

This collection of experiences and experiments in the field of distance education has made us reflect more deeply on the need to evaluate the information that is already available while at the same time seeking to introduce new resources in communication and information technology into the day to day lives of our *traditional* face-to-face schools. This reflexion has been built into a current project the goal of which is the transformation of public education in Bahia.

The transformation of public education in Bahia

I cannot deny the importance of these national distance education projects and programs. Nevertheless, I believe it is necessary to analyze the need for and the size of these types of projects, taking into account the context of each and every Brazilian state. In order to overcome the above-mentioned contradiction, we will reflect upon the feasibility of simultaneously strengthening public learning institutions at all levels as well as promoting greater interaction among them.

In Bahia we have been pondering this issue a great deal since the current situation here leads us, *a priori*, to think that we do not need distance education programs to the degree nor with all the characteristics of other projects that are being implemented in Brazil. With this situation and the current conditions in Bahia in mind, we are analyzing - evidently with many internal conflicts - the real need to implement distance education programs

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2 For more information, see: Alonso, Katia Morosov *Educação a Distância no Brasil: busca de identidade* in Preti, Oreste **Educação a distância - inícios e indícios de um percurso**, Cuiabá: UFMT, p. 57-74, 1996.

without first considering our reality. In particular, we should analyse the presence of public universities in the state as a whole. There are five public universities, spread over 21 *campi*, covering a good portion of Bahian territory.

Within this context, it is important to reflect a little upon the need to establish as a priority a closer relationship between theoretical analyses - produced inside the universities - and the day-to-day life of our primary and secondary schools, giving special emphasis to those professionals who, already in active service, need to be adequately qualified to carry out their activities. Especially if we are referring to the great number of teachers who, without adequate nor appropriate training, work almost heroically in primary and secondary schools, without the minimum academic qualifications to fulfill their roles as education professionals.

The public schools have been abandoned, the teachers are unprepared and are appealing for support. Public universities - good or bad - however, are present in practically all the state. These universities, while also carrying out their activities - under absolutely precarious conditions - are also working with the public education system in each of the regions where they are located.

I believe it is important at this historical moment to use new technologies, that *shrink* distances and bring lecturers, teachers and students from these universities and schools together, to foster group action and build a closer relationship between the public university, secondary and primary school systems.

This combined institutional effort is to support each school, in each region, in the development of a collective process to provide teachers working in the classroom with the necessary academic qualifications and keep them up-to-date.

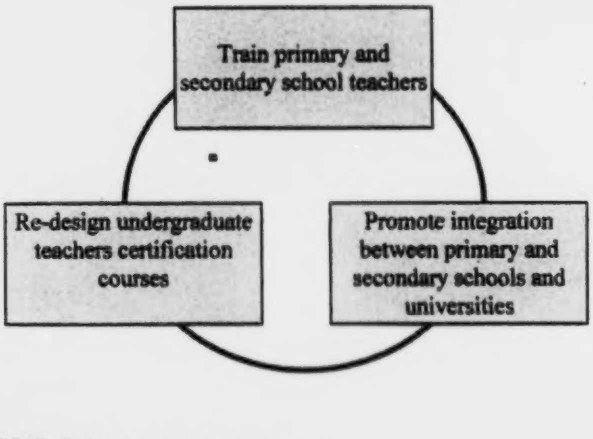
To develop this project it is necessary to examine existing programs and projects, to introduce the new resources in information and communication technologies, to re-direct them collectively in an attempt to diminish the distances that separate the different universities and, principally, the universities and the public education system (primary and secondary schools).

When thinking about *reducing distances*, our aim is not merely to increase the number of people who have access to education via TV broadcasting. The use of these technological resources is fundamental given that they are not only new technologies - forced on us by the electronics industries - but that they are the elements that are structuring a new language, whose form and internal logic are determined by a secret alliance between electronics and the human spirit [Babin, 1993].

Given this perspective, steps should not be taken to create not only *curricula* and didactic programs and materials in a centralized manner to *flood* the school with information, but also, and more importantly, develop a critical awareness.

Therefore, when designing programs to train or develop teachers acting in conjunction with education ministries (federal, state and municipal), universities and public schools taking into account on-going projects at nearby universities, we are promoting a new practice, based on *three basic interdependent elements* [Fig.1].

Figl: Three basic interdependent elements for reducing distances in education projects


Train primary and secondary school teachers
Re-design undergraduate teachers certification courses
Promote integration between primary and secondary schools and universities

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These ***interdependent elements*** are considered ***the minimum requirements*** for the development of the project. Our aim is not simply to develop current training, advanced training and certification programs for teachers, now *at a distance*, using different media. This is no guarantee of new and improved training methods for these teachers. Nor do we simply want to develop current certification programs - or part of them - at the distance, with the *simple* objective of "increasing the number of graduates".

On the contrary, we believe that new technological resources, which make it possible to *take actions at a distance in* ***conjunction*** *with those taken face-to-face*, constitute the *structuring* elements of a new pedagogical vision. This is because, these resources constitute the elements of a new vision of the production of knowledge on the planet on the dawn of a new millennium.

We live in a mass media society and schools need to be equipped and ready to prepare future generations to know how to take advantage of all information available thus transforming schools into a place where people are able to collectively produce culture and knowledge. A new school will be born, with new teachers, working face-to-face with their students supported by these new tecnhological resources.

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Large-Scale Interactive Teaching via the Internet: experience with problem sessions and practical work in university courses

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Abstract: Although Internet technology and the WWW have been hailed as a panacea for education, and distance education in particular, few people are making effective use of the technology or demonstrating scaleable examples, especially in terms of replacing face-to-face teaching. The Open University (UK) is one of the most successful distance teaching universities in the world and this paper presents some of the models attempted and lessons learned from large-scale Internet teaching on computing courses.

Introduction

The World Wide Web has been heralded by the popular press [Reinhardt 1995] as a panacea for education, and for distance education in particular. Suddenly, many conventional universities have started to offer Internet, distance-taught courses constructed from conventional lecture notes translated into HTML with a few hyperlinks. But what about *teaching*? Although such material may be a useful supplement to students studying conventionally, the demands of distance teaching extend far beyond provision of conventional course materials [Mason and Kaye 1989], and the challenges of *effective* remote education concern the quality of a student's experience. Even at a distance, students' interactions with their teachers and with other students give them perspective, place them within a community of learning, and contribute to their mastery of concepts and skills.

Face-to-face teaching and practical sessions (hereafter called 'tutorials') are seen as a focal point in distance teaching, where concepts become immediate and personal through students' interactions with both their teachers and each other. The Open University's early experiences with electronic presentation of courses have highlighted both the importance of face-to-face tutorials in distance teaching, and the challenge of replacing face-to-face tutorials with effective electronic substitutes. Providing effective tutorials outside the constraints of a given room and time has relevance beyond established distance teaching. It is part of the growing need for flexible delivery demanded: *by multi-campus universities*; in disciplines (like Medicine) in which *expert teaching staff is scarce*; in cases where *particular expertise (e.g. technological knowledge) is concentrated in one location*. This flexibility can reduce constraints on instructors as well as students.

In translating the tutorial for Internet presentation, the priority is to preserve the immediacy of the face-to-face tutorial, despite the problems of cost, compatibility and synchronisation that apply. This paper reports experiences of 'electronic tutorials' conducted over two years as part of on-going trials presenting Computing courses via the Internet to students world-wide. It describes the university context, the technology strategy, and the synchronous and asynchronous interaction models used, and it discusses the issues observed during these trials.

Background: the Open University context

Over 26 years, the Open University (OU) has developed a well-tuned machine for providing high-quality university education for part-time students studying at a distance. With more than 150,000 students per year and over 120,000 degree graduates to date, it is one of the most successful distance teaching universities in the world. All OU undergraduate teaching is through 'supported open distance learning'. The teaching and support network for students manifests itself in five distinct aspects: *teaching materials; tutorial support and assessment; counselling support; examinations* and *enquiry services*. Each student studies at home using teaching material delivered primarily by mail but using a variety of media (custom-designed books, CD-ROMs, audio tapes, video on tapes or UK-television broadcasts, laboratory materials). All teaching material is specifically designed for students working independently. This teaching is *supported* because all students are assigned a local instructor, who answers course-related questions throughout the year via telephone conversation or written correspondence, or during one of the regularly scheduled face-to-face tutorials when the students and instructor meet at in a conventional classroom setting for 1-2 hours. Throughout the course, the student is required to submit written assignments which the instructor grades and annotates, providing essential feedback.

The challenges for a large, distance teaching university include: scale; a commitment to access, despite hugely varying student circumstances; rigorous quality control which must be completed before courses are presented; and rapid feedback to a dispersed student population.

Scale: With over 300 courses offered in a variety of undergraduate and post-graduate degree programs, and with as many as 8,000 students in some courses, scaling for student numbers requires considerable organisation and efficient administration.

Access: The OU has no barriers to entry: the ethos of the university is to be "open and equal". Removing or minimizing the barriers to study makes 'cost', supply, and other practical considerations crucial in the use of technology. The principle of access also extends to flexibility: over 70% of students are working full-time and studying part-time, so their learning must fit around other responsibilities. In the past, people have studied with the OU from places as diverse as airplanes, cruise ships, oil rigs, or even nuclear submarines. The conventional OU study system copes well for students in these situations, and changes involving electronic communication must not disenfranchise them.

Quality control: Courses are designed by a multi-disciplinary team producing custom text, software, audio cassettes, video for broadcast, and CD-ROMs. All materials must be completed and evaluated in advance; courses undergo rigorous developmental testing with a student cohort before presentation. A pre-eminent commitment to quality teaching demands that technology be made to serve education, rather than teaching chasing technology.

Rapid feedback: Even though 40,000 assignments are processed per week, the students usually receive their marked assignments within a week of the instructor submitting them. Retaining and motivating students hinges on rapid feedback, which makes communication (paper-based or otherwise) a key issue. This has been one of the barriers to the OU teaching outside the UK, where communication systems are often less reliable.

Internet communications strategy

The commitment to access has a profound effect on how courses are designed and what may be required of students; courses may not impose an onerous burden in terms of powerful machines or expensive network access. Although electronic communication has played a part in some OU courses for well over a decade, until recently this has been limited to a small number of courses where electronic communication was a topic in the course, and a few hundred students used one of two proprietary local conferencing systems. For the past three years, the OU has also been adopting a separate Internet-based strategy for world-wide delivery of supported distance learning courses. The university itself is effectively a very large national Internet Service Provider for its students, with local dial-in points throughout most of the UK. Nevertheless, students must pay per-minute charges for local telephone calls, and so Internet access software must provide some method of off-line working to help students minimize call charges. Over 30,000 students will make use of dial-in access to the university in 1997.

Given the current rapid developments in Internet technology, it would be tempting to develop an electronic communication strategy by assuming that students gain fast connection to the Internet via ISDN, or even a direct connection to an MBONE site--such as the one proposed by Watabe and colleagues [Watabe et al. 1995]. However, although it appears to be relatively 'future-proof', allowing advances to be built onto the present system, its current cost is prohibitive for an institution committed to access. This does not mean that the OU cannot use fast network connections to deliver high bandwidth material for teaching. It *does* require a policy of *graceful degradation* so that, as a student's personal computer specification or the speed of connection to the network decreases, the student can still receive a suitable version of the interactive component of the teaching.

The assumed 'least common denominator' in equipment is access to an offline e-mail facility and the ability to decode attached MIME or uuencoded files. No assumption is made about the speed of the student's connection, which could be as low as 1200 baud. But, for the majority of OU students, the minimum hardware specification is an 8-Mb PC running Windows 3.1 with a 14.4 kbaud modem, significant numbers of students now have higher specification machines running Windows 95 and use higher-speed modems to access the OU.

All students are provided with the Netscape browser (supporting some HTML, Java, WWW file uploads, and integrated off-line e-mail), although they may use almost any WWW browser if they prefer. The university provides PPP dial-up points in the UK and POP e-mail for off-line e-mail reading, although students outside the UK are recommended to find their own Internet Service Providers with local e-mail, in order to avoid long distance telephone calls or long waiting times on Internet connections.

The experience reported here is within this Internet-based strategy: the trial presentation of Computing courses via the Internet. The first trial in 1995 involved 29 students in 9 countries studying entry-level Computing with 2 UK instructors. Its successor in 1996 has involved approximately 300 students and 22 instructors on an entry-level course, and 50 students and 2 instructors on an upper-level course, using new electronic tutorial models, improved marking tools, and more sophisticated conferencing. In 1997, over 500 students from all over the world will study a range of courses supported by at least 25 instructors.

Four main communications facilities were employed in the 1996 trial:

i) **E-mail**: Students were provided with clients for off-line mail systems (Eudora and Netscape Mail). They could send message to their instructors, to fellow students, or to groups via a mailing list facility connected by gateway to the web-based conferencing system. Many students and instructors constructed their own special-topic mailing lists. Students were required to check their e-mail regularly.

ii) **Web-based conferencing**: The main asynchronous text-based conferencing system was based on the Hypernews system (http://union.ncsa.uiuc.edu/HyperNews/get/hypernews.html), with some additions to facilitate course organization, and with e-mail gateways so that it could be used to broadcast messages via e-mail as well as the conference. Students who had only e-mail access could post into the conferencing system--into the appropriate thread--by sending to a special e-mail address. Anyone in the conferencing system could elect to receive all postings to any thread or sub-thread as e-mail, so that they needn't check for new messages; hence use of the conferencing system was effectively optional. Instructors used the conferencing system to construct tutorials in HTML and to conduct discussions in their tutorial groups.

iii) **Internet Relay Chat**: Internet Relay Chat (IRC) provided a synchronous text-based discussion facility to all students with the standard equipment described.

iv) **Enhanced CU-SeeMe and RealAudio**: For the audio-graphic tutorials, students in the upper-level course (all with sound capability) were provided with Enhanced CU-SeeMe software (http://goliath.wpine.com/cu-seeme.html), which gave them a slow-scan video image of the instructor, an IRC-like synchronous text chat facility, a shared 'whiteboard', and limited two-way live audio. For better audio quality, students were also provided with RealAudio software (http://www.realaudio.com/).

What do students want from tutorials?

Distance students often report a feeling of isolation when studying because of their lack of contact with an instructor or other students. The emphasis on electronic tutorials arises from previous experiences of electronic presentation, as well as from earlier analyses of what students derive from face-to-face tutorials. The benefit to students is only partly academic; the tutorial is an important social focus that allows students to build relationships with their instructors and other students. Students report that tutorials provide:

i) a chance to meet the instructor who is marking their work;

ii) demonstrations of expert behaviour, worked examples, an alternative look at the course material;

iii) structure; milestones; incentives; an indication of the appropriate emphasis or degree of importance for various topics in the syllabus;

iv) pointers about the kind of problems they will face in assignments;

v) learning from other students' questions, mistakes, insights;

vi) reassurance that the student is making appropriate progress, and that the student's progress is comparable to that of other students;

vii) social contact with other students (Tutorials are crucial in establishing student networks, etc.)

OU statistics over years indicate that students who attend tutorials tend to perform better than those who don't. However, poor or less-confident students tend not to attend tutorials, and nor do busy or remote students or those unable to travel. For students who cannot attend face-to-face sessions, electronic communication can help overcome many of the problems faced by distance learners [Alexander 1992].

What is a typical face-to-face tutorial?

In the broadest characterization, face-to-face tutorials tend to have two main parts:

i) a diagnostic component, in which instructors clarify where students are with respect to coursework and answer any questions, and in which they reflect on a previous assignment, giving attention to points of difficulty;

ii) a lecture or problem-solving component, in which instructors present examples and issues and elicit discussion, or in which students solve and discuss problems.

Instructors are given a 'free hand' in running their tutorials, but the 'typical' tutorials they report fall into three general formats:

i) open question and discussion sessions which are student-centred.

ii) lecture-type sessions which provide an augmented view of the course material, either through additional explanation or worked examples.

iii) workshop-type, problem-solving or practical sessions in which students work individually or in small groups on problems of varying difficulty. Interaction and discussion are emphasised.

Models attempted

At the start of the term, several electronic tutorial models were suggested to the instructors; the suggested models tried to accommodate both the constraints and the opportunities inherent in electronic communication in order to provide valuable tutorial functions with the simplest effective technology--hence the emphasis on structured, asynchronous tutorials. Among the suggested models were the 'asynchronous problem-solving and discussion' model and the 'asynchronous group working' model which appear in Table 1. The instructors adjusted those models and invented new ones to suit their own teaching. Tables 1- 3 present a distillation of those experiences, grouped by mode (asynchronous, mixed, and synchronous) and ordered by the number of examples.

NOTE: Tables 1-3 appear in the electronic version of this paper only

Issues:

duration of tutorials: Preliminary results suggested that deadlines and milestones are important in electronic tutorials, and so early asynchronous tutorials were held over 2-3 days, often a weekend. However, many instructors reported that 2-3 days just wasn't long enough, and that they had more success with the week-long tutorial. The advantages of the longer period include:

- time for students to reflect on or to re-try exercises
- time for busy students to 'look in' (hence better 'catchment')
- the opportunity to tackle problems of realistic size, rather than mini-problems -- partly because the tutorials can be cumulative, and a momentum can be created.

tutorial group size: There is no clear indication of optimum group size. Active participation in the tutorials was low, but a good interaction could be achieved with 3-4 students, and instructors remarked that many students were known to 'lurk'. In general, the pattern of participation appears to have followed the pattern observed in other conferencing studies: 1/3 are active participants; 1/3 are occasional participants; 1/3 lurk when they have time.

instructor teams: Those instructors who were able to collaborate with one or more other instructors seem to have benefitted, both by sharing the load (and thereby giving students better coverage) and by having the contact: instructors appear to get some of the enthusiasm from each other that they miss from face-to-face tutorials. Some of the best reports come from combined-group tutorials.

participation: Participation appeared low, but several instructors remarked that it was comparable to attendance at face-to-face tutorials. Instructors and students both remarked that electronic tutorials reached students unable to attend face-to-face tutorials. 'Attendance' at tutorials tended to drop off, but was revived by alternative tutorial strategies (e.g., role play) and by other mechanisms (e.g., requiring students to register in order to participate).

lurkers: Instructors consider it an advantage that some students can lurk, but lurkers pose a disadvantage for instructors: less feedback. In face-to-face tutoring, there is still some interaction with passive students, and instructors cater for a sort of 'passive absorption'. In electronic tutoring, the lurkers are 'invisible' and the instructor may feel that few students are attending. Many instructors reported that nearly all of the students in their groups read the tutorials, even if they didn't contribute: *"Even those students too shy to join in later said they followed the exchange of emails and said they found it useful."*

interaction: Several instructors reported that they get *more* interaction in their electronic tutorials than in their face-to-face tutorials. However, several instructors reported that they couldn't raise any interaction at all. About interaction, both instructor and student experience are divided -- some successes, some disasters. What evidence we have suggests that including some synchronous device like IRC is likely to increase the satisfaction with interaction: *"I think the IRC experiment was successful in that students enjoyed the interaction together"*. Most electronic students do report that their rapport with their instructor has developed during the course (although this varies among instructors). Instructors report that students are adapting to the medium, too: *"...students are getting used to the idea of sending comments or queries with their messages..."*

jokes: It may be worth noting that the instructors' most common answer to *"What can't you reproduce in electronic tutorials"* is *"the jokes"*. But in the 'successful interaction' groups, there is plenty of humour.

instructor buzz: Instructors get value from face-to-face tutorials, too, which many lose in electronic tuition: a satisfying 'buzz' from the interaction with the students. Some do not view electronic tutorials as enjoyable. Contributing to this perception are a lower rate of interaction and a lack of feedback -- instructors do not get immediate reassurance that the students are understanding them, the interaction is less intense, they cannot count heads, etc.

preparation and quality of teaching: The instructors who participated in the 1996 trial were all experienced, highly-regarded instructors. They already had a repertoire of effective practice in face-to-face tutorials; and they already had material in hand. What success there was is attributable to the excellence of the teaching: the careful preparation, the nature of the setting and structure, the guidance, the quality of interaction, the ability to re-phrase explanations, appropriate milestones, time invested, and so on--including the ability of these instructors to adapt to the new medium. But the failures are *not* attributable to the instructors; in many cases, the same model -- even the same material -- had been a success in another group.

With feedback uncertain, instructors must be prepared to hold a tutorial 'in a vacuum'. Explanations previously offered on-the-fly from notes must be presented in coherent prose, and that prose becomes available for re-reading by the students. More preparation is required, at least initially, than for face-to-face tutorials.

the 'continuous' tutorial: Several instructors proposed (and to an extent implemented) the 'continuous' tutorial, with some problem or question current nearly all the time, but with topics rolling over on a regular basis. Obviously, this requires more instructor time, and it must be monitored and revitalized if it flags.

scope of material: Some instructors claim that they cover *more* material in electronic tutorials, and that they can tackle more realistic problems, in part because the tutorials last longer, and in part because they can be cumulative. However, several instructors have expressed concern that they aren't really able to present alternative forms of information; whatever they do is largely in text, rather than through more direct interaction: *"We can't stand up and wave our hands about."*

group work: Although several of the group work tutorials were considered successful, instructors found it difficult to initiate group working (as evidenced by the few examples), and there is clearly a need for better mechanisms for group working. Two ingredients of the successful groups were 'registration', so that students had to sign up for the tutorial in advance, and role playing.

replayable material: One benefit of electronic tutorials is that most are automatically recorded and can be reviewed 'off-line' either by participants or non-participants. This was an advantage in off-setting some of the problems; for example, difficulties in synchronising a geographically-dispersed tutorial group are balanced by opportunities for automatic recording and replay of interactions. At least one of the instructors who ran IRC tutorials distributed the log files to all students in that tutorial group.

diagnosis: In conventional distance teaching, diagnosis is concentrated in the face-to-face tutorial sessions. In Internet teaching, diagnosis has become decoupled from the tutorial, so that diagnosis is a continuous activity on email. Some instructors introduced regular diagnostic mechanisms, such as a fortnightly query to students on their understanding of some aspect of the course, or just a question about whether they were comfortable with the material. Sometimes asynchronous communication can be disadvantageous when trying to diagnose a particular student problem. Instructors have remarked that students show a reluctance to commit things to the record, and hence they are concerned that problems may remain unexpressed.

demands on students: Instructors wondered about the demands on students: *"I'm worried that we're loading the students too heavily."*-- requiring more time and effort from each student. Asynchronous collaboration with other students involves longer elapsed time, whereas collaboration in a conventional tutorial happens within a fixed couple of hours. And 'passive absorption' is less obviously available: *"You want an element of 'sit back and take this in' and it will help you--I find that hard to put into an electronic tutorial."*

supporting materials: Experience emphasizes the additional need for supporting materials: post-mortems, examples, structured reviews--material that reiterates, re-illustrates, and emphasises the structure of course materials. One instructor instituted the 'tutorial checklist': a list of what the student should understand after the tutorial.

Lessons:

Opinion on electronic tutorials is divided: some groups work, and some do not. On the basis of these trials, we cannot attribute failure to any particular model, nor can we attribute it to any particular instructor. We can, however, list some factors we believe contribute to success, whatever the model.

The key seems to lie in bringing the social interaction alive. Some instructors and students seem to achieve this through asynchronous text, whereas others may need a 'social starter': a face-to-face tutorial, IRC, video -- some way of conveying personalities within the group. Humour matters: most instructors complain that they don't get a chance to joke, but the successful tutorials had plenty of humour in them. Humour is an important enlivener.

Students are surprisingly resilient, especially when the choice is between electronic tutorials and nothing. Students adapt to the technology, the protocols, the limitations, the possibilities.

Structure matters: most of the successful tutorials were presented in stages, with clear tasks and milestones, and a clear review of the material covered. In the first presentation, this entails considerable preparation; but in subsequent presentations, or within a different structure of team teaching, that preparation could 'pay off' in re-use.

At this level of technology, electronic tutorials are no substitute for face-to-face tutorials, although they clearly have value and tremendous potential. And yet the potential must be realized at this sort of level--where technology is inexpensive and available--so that technology makes education accessible rather than exclusive.

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The Design of a Cognitive Flexible Hypertext Learning Aid to Teach a Structural Model of Implementation.

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Abstract: The design of a Cognitive Flexible Hypertext Learning Aid to teach a structural model of Information Systems Implementation is discussed. Advantages of using a nonlinear medium, such as hypertext, as a learning aid are the freedom to examine information in any order, the possibility to organize any type of information, and, to find things and absorb ideas easier and faster. Constructivism assumes that individuals learn better when they discover things themselves and when they control the pace of learning. The Cognitive Flexibility Theory claims that revisiting the same material, at different times, in rearranged contexts, for different purposes, and from different conceptual perspectives is essential to attain the goals of advanced knowledge acquisition. These concepts were used to design a learning aid to teach the [Lucas et al. 90] structural Information Systems Implementation model.

Hypertext/Hypermedia

Hypertext, Hypermedia, a computerized form of information, is seen as nonlinear prose, interactive print, or dynamic text. It is usually defined as the nonlinear viewing of information. "Nonlinear" means that information can be examined in any order by selecting the topic to see next. It provides a new way of accessing and organizing any type of information. Hypertext can make it easier and faster to find things and absorb ideas.

Researchers and practitioners of hypertext claim that it will revolutionize information systems and cause designers of information to reexamine widely held beliefs and practices relating to publishing, text and screen design, information access and retrieval, user support, and documentation management. Hypertext's cognitive power comes from visually representing the hyper web on the screen to show available links and nodes or updated user paths. Hypertext provides a mental model for representing ideas by transforming the unobservable into objects that can be examined and inspected. Hypertext systems are being used extensively nowadays in many fields, from software engineering to collaborative problem solving applications, as on-line documentation, information retrieval and help systems, as writing aids, and more recently as authoring tools for instruction and learning.

Hypertext, Learning and Education

Historically, instructional usage of computers for training and learning has evolved through different stages: In the 1960s and 1970s, a variety of computer-assisted instructional (CAI) programs were developed. Most of these programs, however, did not meet the expectations that educators had for the new medium. Learning and training via computers were usually based on inflexible presentations of didactic material. Early teaching programs were limited by the hardware then available, and by the only available guide for instructional development: Behavioral Theory.

During the 1980s, Integrated Learning Systems (ILS) were created. ILS are the integration of hardware, software, and curriculum for instruction. These systems are accountability driven, providing continuous performance feedback (i.e., how many questions were answered correctly, how many were wrong, how many were completed). Thus, even though trainees or learners may be working on a variety of topics, skills, or tasks, the system gives the trainer or instructor a very detailed analysis of what work has been done at each station.

Researchers in Artificial Intelligence and Cognitive Science have recently developed additional types of training and educational software: Intelligent Tutoring Systems (ITS) and Cognition Enhancers or Computer-Based Learning Aids (CBLA.) Among the emerging cognition enhancers, we can group those known as *Empowering Environments, Hypermedia*, and *Microworlds* [Brown 85]. The concept underlying a cognition enhancer is that the complementary cognitive strengths of a person and an information technology can be used in partnership [Salomon et al. 91]. Still, the cognitive attributes of human beings give them an advantage over computers in applying peripheral real-world knowledge to ill-structured problems.

Results from preliminary studies have suggested that hypertext-based systems can be usefully applied in training and learning and that it is worthwhile to generate further material for this medium [Locatis et al. 89; Hammond 89; Duffy and Knuth 90; Ess 91; Jones and Spiro 92; Michalak and Coney 93; Madigan et al. 94]. Although all these research studies have proven the usefulness of hypertext technology for training and learning, still no one has demonstrated any appreciable advantage for hypertext. Like many new technologies brought to education, more claims have been made on hypertext's behalf than the experimental evidence has been able to support. Our position here is that hypertext is not the solution for every problem in education, but it is a solution for some problems. The sort of problems that by using hypertext's unique structure either lessen the complexity of the problem and/or ease the learning process. The challenge is twofold: to find those problems, and to implement them successfully in hypertext.

Constructivism

In brief, Constructivism is a theory of knowledge derived from the philosophical proposition that reality is created or constructed by the individual. Constructivism claims that reality is more in the mind of the knower, that the knower *constructs* a reality, or at least interprets it, based on her own perception. While the emphasis in *objectivism* is on the *object* of our knowledge, *constructivism* is concerned with *how* we construct knowledge. Knowledge construction varies with experiences, mental structures, and beliefs that one uses to interpret objects and events.

Radical constructivists believe that there is no real world, no objective reality independent of human mental activity. A less radical approach holds that the mind is instrumental and essential in interpreting events, objects, and perspectives in the real world, and that those interpretations comprise a knowledge base that is personal and individualistic. According to these less radical constructivists, thinking is grounded in perception of physical and social experiences, comprehended only by the mind. What the mind produces are mental models that explain to the knower what he or she has perceived. One important epistemological assumption of these theorists is that meaning varies with how the individual creates meaning from his or her experiences.

The constructivists' views can be summarized as: (1) There is a real world that we experience. (2) Meaning is imposed on the world by us, rather than existing in the world independently of us. (3) Meaning is seen as rooted in, and indexed by, experience [Brown et al. 89]. (4) Constructivists emphasize "situating" cognitive experiences in authentic activities, such as *Cognitive apprenticeship* [Collins et al. 89]. (5) There is no ultimate, shared reality, but rather a reality that is the outcome of constructive processes.

A major assumption is that individuals learn better when they discover things themselves and when they control the pace of learning. The purpose of instruction moves away from knowledge dissemination towards knowledge creation. The process of creation is more important than the knowledge created, since it can be redesigned later, when new connections or structures are developed.

Following the interpretation of [Spiro et al. 88] we see constructivism in learning and education as a new understanding, constructed when various sources of knowledge are put together. With such an interpretation, they developed the Cognitive Flexibility Theory, which adds a new element of constructive processing to those already accepted within Constructivism, an element concerned mainly with the flexible use of preexisting knowledge (i.e., new understandings are constructed by using prior knowledge to go beyond the information given; preexisting knowledge is itself constructed on a case-by-case basis.)

Cognitive Flexibility Theory

Cognitive Flexibility Theory is a conceptual model for instruction based upon cognitive learning theory and attempts to avoid oversimplifying instructions, provides multiple representations of content, emphasizes case-base instruction, focuses on context dependent knowledge, and supports the natural complexity of the content domain to foster the development of advanced knowledge, particularly in ill-structured knowledge domains [Spiro et al. 88.] Cognitive Flexibility Hypertexts are designed to engage learners in more meaningful, transfer-oriented, advanced knowledge acquisition.

The central claim of Cognitive Flexibility Theory is that revisiting the same material, at different times, in rearranged contexts, for different purposes, and from different conceptual perspectives is essential to attain the goals of advanced knowledge acquisition. Content must be covered more than once for full understanding to a point that associations among elements will become apparent. If some of these associations are not grasped on a first exploration, they may be noticed on a second or third attempt.

If we take into account all the previously mentioned factors, it's simple to see that the main metaphor employed in the instructional model derived within Cognitive Flexibility Theory is that of the crisscross landscape [Spiro et al. 88.] This metaphor suggests a nonlinear and multidimensional traversal of complex subject matter, returning to the same place in the conceptual landscape on different occasions, coming from different directions. The instructional model suggests that hypertext, with its nonlinear properties, is a viable technology for building this crisscross landscape.

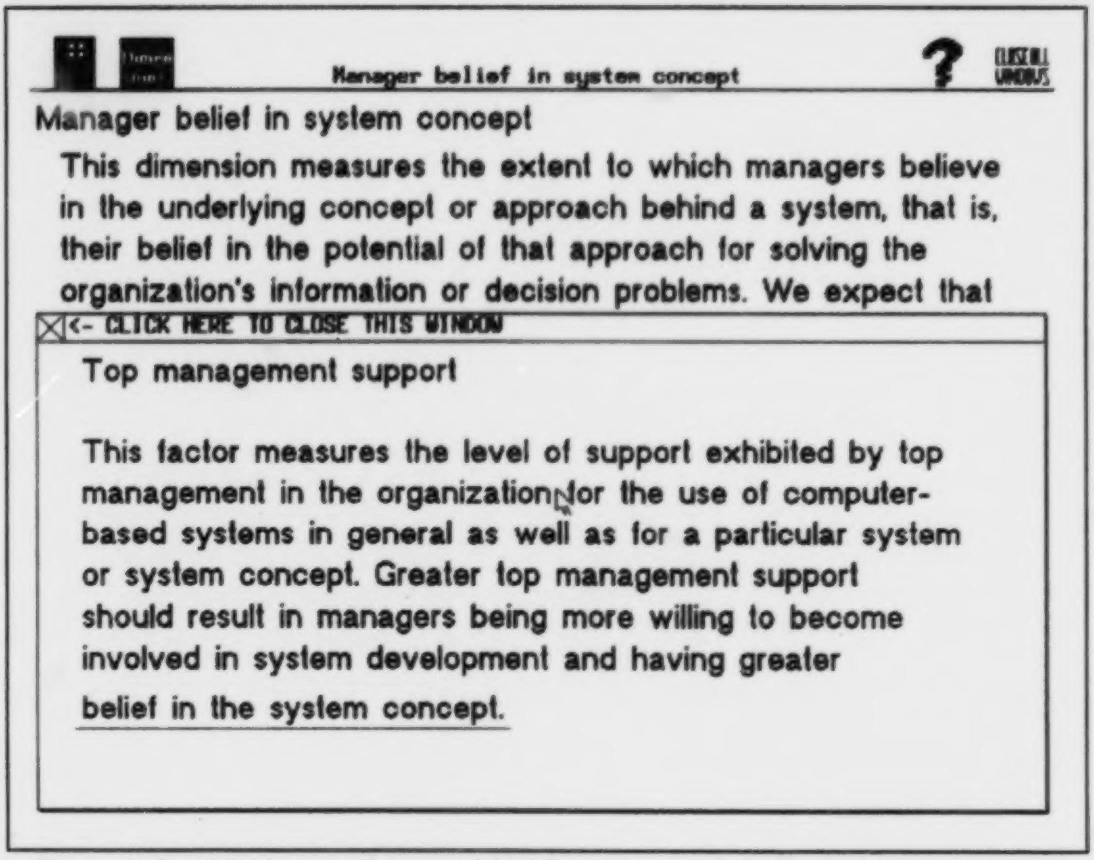
The Design of a Cognitive Flexible Hypertext Learning Aid.

[Lucas et al. 90] developed a structural model of implementation that incorporates many of the results of past implementation research studies. It is based on the research traditions of causal modeling, attitude modeling, and innovation process modeling. They use this approach to explain the phenomena of systems implementation with a conceptual model rich in theoretical implications but complex. Its complexity has been a deterrent to its inclusion in the Information Systems (IS) Curriculum.

The variables included in the model are based on the research findings of previous implementation studies. The model consists of two separable submodels, the *user model* and the *manager model*. The logic of the model is that implementation begins with management initiation and acceptance of a given IS and ends with user satisfaction with the system. Factors leading to manager acceptance are personal (*Manager Decision Style, Manager Demographics*), task related (*Manager Job Characteristics*), and system-specific (*Manager Knowledge of System, Manager Assessment of System and Support*). *Top Management Support* is seen to influence both *Manager's Belief in the Systems Concept* and *Manager's Involvement* with systems development. Beliefs and involvement do not directly lead to *Acceptance*; rather stronger belief leads to more involvement. Also, both stronger belief and more involvement lead to more knowledge of the system. All this to say, that some factors depend on other factors which increases the complexity of the model.

The *manager model* was implemented in Hypertext by the author under the light of Cognitive Flexibility Theory. The Hypertext module consists of nine screens and ten windows. Each dimension (Manager Belief in System Concept, Manager Knowledge of the System, Manager Assessment of System and Support, Manager Involvement, and Manager Acceptance) is presented on a screen. These screens contain their definition and links to the factors or dimensions that have a direct influence on them. Through the links, the windows containing the information of the factors and influencing dimensions are presented when a link is selected. Links are filtered through programs that highlight the relevant information concerning the selected factor or influencing dimension; this is one of the powerful characteristics of hypertext that provides reinforcement in the learning process [Fig. 1 and 2]. The screens also contain linear links through labelled arrows that allow the user to traverse the information sequentially.

This design besides providing reinforcement in the learning process, directly uses hypertext's cognitive power. As mentioned previously, by showing available links and nodes on each screen, learners visually construct the hyper web which is a representation of the expert's mental model. Also, by revisiting a given factor or dimension, at different times, from different variables with different highlighted information, associations will become apparent.


Dimen sions
Manager belief in system concept
?
CLOSE ALL WINDOWS
<- CLICK HERE TO CLOSE THIS WINDOW

Manager belief in system concept

This dimension measures the extent to which managers believe in the underlying concept or approach behind a system, that is, their belief in the potential of that approach for solving the organization's information or decision problems. We expect that

Top management support

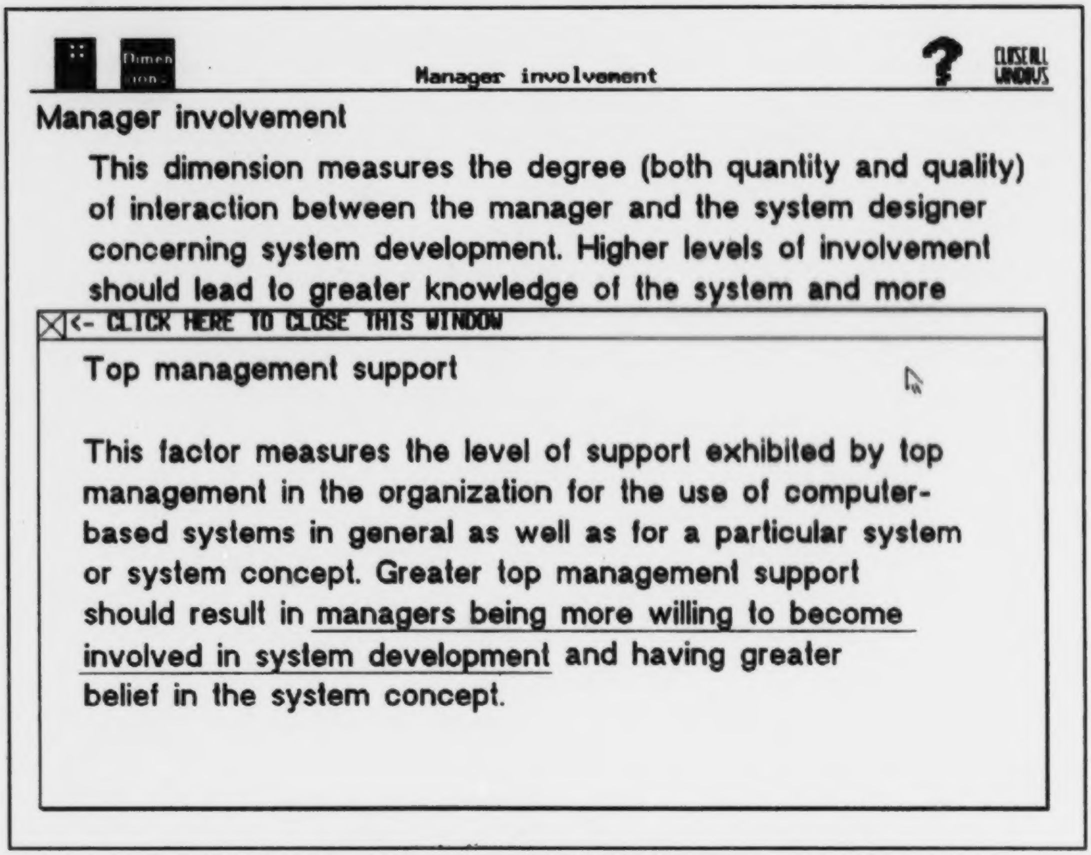
This factor measures the level of support exhibited by top management in the organization for the use of computer-based systems in general as well as for a particular system or system concept. Greater top management support should result in managers being more willing to become involved in system development and having greater belief in the system concept.

Figure 1: Top Management Support visited from Manager Belief in the Systems Concept.

This is some kind of a cognitive "click" which allows learners to "know" that they have learned something new.

The module also includes five linked icons: *Dimensions, Close All Windows, Help, Notes* and *Exit Door*. With the *Dimensions* icon, users can revisit the dimensions' screen containing a brief explanation of the model and links to each dimension. The *Close All Windows* icon allows users to close all open windows and keep on working in the active screen. *Help* opens a window containing a list of the possible actions to take given a particular situation. The *Notes* icon opens an online file where users can type some notes. Once the online file is open, a sixth icon is presented: the *Printer* icon allows users to print the contents of the online file, if there is a printer available. Students may quit the application using the *Exit Door* icon.

All these elements are put together to allow learners to experience the model actively instead of passively. Learners can move back and forth within the model to "discover" the relations between dimensions and factors. These relations also help the understanding of the dimensions and factors themselves.



Manager involvement

This dimension measures the degree (both quantity and quality) of interaction between the manager and the system designer concerning system development. Higher levels of involvement should lead to greater knowledge of the system and more

Top management support

This factor measures the level of support exhibited by top management in the organization for the use of computer-based systems in general as well as for a particular system or system concept. Greater top management support should result in managers being more willing to become involved in system development and having greater belief in the system concept.

Figure 2: Top Management Support visited from Manager Involvement.

Strengths and Limitations

The model was designed within the philosophy of constructivism. One of the assumptions that work well in this model is that meaning varies with how the individual creates meaning from his or her experiences. Unless learners choose to traverse the information sequentially, no two learners will have the same experience. Each of them will create her or his own construction of the same implementation model. That does not mean one will be right and the others wrong; the model is the same, just the understanding of it will be different.

An important feature of the learning module is that it allows learners to selectively visit each dimension and the factors/dimensions that have a direct/indirect influence on them. This option provides a way to show the pattern of association (by means of the highlighted information) which reveals the conceptual information of the model. Then, by exploring, in a constructivist manner, students are actually learning.

One important limitation is the fact that complex models are difficult to implement. The amount of information necessary to show differences that exist mainly in perception can escalate rapidly. Sometimes it may be unfeasible to attempt it; in others may be irrelevant. One of the most important learning experiences, derived from this design, is the acknowledgement that finding a workable balance between feasibility and relevancy is the main goal when designing instructional material for hypertext.

The main limitation of using hypertext in learning has been determined to be disorientation (*lost in hyperspace*.)

To prevent this problem, the module contains the *Dimensions* icon, which takes students to the first screen of the module. Therefore, every time a student needs to revisit the list of dimensions, wants to visit a specific screen, or does not know what to do, by clicking on the *Dimensions* icon, he/she will be able to get back to a "safe" location. The title of each screen refers to the dimension under discussion. The *Help* icon provides information on the options available any time it is requested. With all these aids, disorientation is unlikely.

Implications for Future Research

Hypertext is not the solution for every problem in learning. There are many aspects of learning where hypertext does not have a meaningful contribution. What is needed then, are some criteria to determine which aspects of the learning process are better served with hypertext. Those areas where information is not linear, or where by imposing linearity the information is not oversimplified, are excellent choices.

The new hypertext learning aids should foster learning by discovery in a constructivist way, bring some kind of structure to ill-structured material, and allow material to be revisited at different times, in different contexts. If the amount of information is overwhelming, it should be broken into modules and meaningful links should allow the traversal of each of them from different parts of the system. If necessary, the system should provide "guided tours" to the information. One aspect to investigate on these guided tours, is whether they promote motivation to learn.

The next step in our research will be to test the benefits of learning using the hypertext module. Currently we are conducting a pilot study to validate the module. Later we will conduct a controlled experiment to measure differences in performance in a problem-solving situation, if any. We expect to find evidence to support the claim that performance will increase proportionally to the complexity of the problems to be solved by those subjects using the hypertext learning aid.

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CourseWeaver
A Tool for Building Course-Based Webs

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Abstract: Many instructors find the development of course webs difficult because few web development tools provide the many facilities that course webs often require. One such requirement is that for multiple "views" of the same collection of information: one designed to be navigated online, one to be printed and distributed. Another is an appropriate way to ensure that pages are formatted in the same way and to propagate design changes. CourseWeaver is a freely distributed tool for building course webs, whose development is based on experience constructing and evaluating student use of course webs [Rebelsky 1994, 1996]. CourseWeaver is designed to meet the needs of the typical course web designer, particularly one with little experience. As such, CourseWeaver prompts for appropriate components, automates much of the construction of course webs, permits easy reorganization and multiple views of course webs, and accommodates significant customization. This paper reports on the motivation, design, and applications of CourseWeaver.

1. Introduction

The enormous growth of the World-Wide Web (WWW) [Berners-Lee et al. 1994] has led a number of instructors to begin to build webs of resources for their courses. Yet the design of a useful course web is still a complex process, involving many steps that can be partially or fully automated. These steps include,

- HTML markup, which many prefer to do using fully or partially WYSIWYG ("what you see is what you get") tools.
- Appropriate reuse of previously developed materials, particularly materials developed for a prior session of the course.
- Uniform formatting (and reformatting) across web pages, not only to give the site a uniform "feel", but also so that students can develop strategies for reading pages.
- Overall web organization, which will be similar for many courses.
- Presentation of course materials in multiple forms — not only (1) online webs with small pages, but also (2) printed pages that collect together smaller pages, and (3) stand-alone applications.
- Version control, so that prior versions of the web may be made available, and so that it is clear what changes have been made.
- Construction of outline-like components, such as the course syllabus or tables of contents at the beginning of printed pages.
- Extendibility, so that new kinds of components can be easily added.

CourseWeaver is a free application designed to meet the needs of the course designer. It guides the web designer through many of the steps in course web design, automatically generates multiple versions of the course web and of navigational structures and allows more advanced web designers to add new templates and change the design of web pages. The following sections further explore the design, use, and benefits of CourseWeaver.

CourseWeaver's Model of Course Webs

A CourseWeaver web consists of an extended collection of basic information elements (hypertext nodes) arranged within the traditional course handout structure (e.g., assignments, class outlines, informational guides). It differs from the traditional handout structure in that components can be freely reused and refer to other components. To facilitate design, organization, reuse and configuration of course webs, CourseWeaver employs three general structural classes in describing webs: nodes, documents, and sites. Both nodes and documents may appear in a variety of specialized versions (e.g., each type of handout is a specialized version of the document class). Each component of CourseWeaver web is an instance of one of these generic or specialized structural classes. For example, a particular assignment is an instance of the assignment class, which is itself a specialized version of the document class.

CourseWeaver *nodes* are small pieces of information (at most a few paragraphs) which provide the primary data that the site presents. In addition to generic nodes, CourseWeaver also provides problem nodes (nodes which are extended to include complexity levels, point values, and other pertinent information) and example nodes (which are extended to include links to corresponding problems and ideas). Although CourseWeaver does not enforce a particular node size, good hypertext design suggests that nodes be kept small (e.g., [Berners-Lee 1994] [Nielsen 1996]).

CourseWeaver *documents* are hierarchical collections of nodes (or, more accurately, references to nodes). Documents resemble the high-level outlines instructors often use when writing handouts -- they describe organization, but not detailed information. Documents provide the low-level structure for the web, as they describe the relationship of different nodes according to a particular use of those nodes. Each document effectively presents a trail [Bush 1945] through a subset of the nodes — an organized sequence that provides one way to traverse the web. Because these trails may be written as hierarchies, they can also provide high-level overviews of how to traverse documents (e.g., one can only look at the top level nodes, without descending into further details.) Documents also provide context for individual nodes, so that a student navigating a CourseWeaver site can determine how the current node is used and what materials are pertinent to that node in various trails through the web.

CourseWeaver *sites* provide the high-level structure of course webs. Each site lists (1) the classes of components used in the web; (2) the names used to describe each class; and (3) the components within each class. The class/name pairs provide a simple context for each document and allows designers to use the same class in multiple ways. For example, one might use the assignment class for laboratory assignments, homework assignments, and perhaps even quizzes and exams. Components within each class are listed so that they may be numbered (providing some context).

Every components of a CourseWeaver structure contains a number of elements that may be filled in by hand or automatically by CourseWeaver. All components contain

- one or more *labels*, which are used for hypertext links and references;
- a *title*, which is used in generating pages, and in building the default text for links;
- a *version number*, which permits both updates and historical views;
- a *creation date*, which is primarily used for information purposes;

- a *modification date*, which is used to inform students of updates and to permit "snapshots" to be taken of a structure (e.g., an instructor can automatically extract the version of a web for a particular date); and
- a *release date*, which aids in building syllabi and ordering components.

An author need fill in only title, as CourseWeaver can automatically generate the remaining fields. However, authors are allowed to fill in the remaining fields.

Three dates are used because each plays a separate role or roles. The creation date is used primarily for historical overviews, but can also be used for notification purposes. Since many instructors create materials long before they use them, the release date provides a within-course context for each component (so that a student knows when a piece of information becomes "valid" for the course or so that CourseWeaver can only incorporate released materials). The modification date helps students (and instructors) keep track of changes and allows CourseWeaver to manage a history for the structure.

Other components may include additional elements. In particular, nodes also contain data fields, documents contain node hierarchies, and sites contain document hierarchies. Similarly, specialized classes include still more information. For example, assignments may also include a due date, an expected length, and a set of readings. CourseWeaver employs this "fill-in" based authoring for a number of reasons, particularly to ensure uniformity among pages and to help ensure that novice course web designers remember to include pertinent information.

Other than this three-level segmentation, CourseWeaver does not significantly restrict the ways in which each class can be used. There is no restriction against reuse; or example, the same node can be referred to by multiple documents and the same document can be used not only by multiple sites, but also in multiple positions within the same site. There is also no enforcement of use; for example, one can build a site that only uses some of the documents in the CourseWeaver collection. However, unused portions will not be available when CourseWeaver builds a web from the components.

Weaving CourseWeaver Webs

After writing the components, the instructor can ask CourseWeaver to build an appropriate set of HTML pages for online and printed versions of the site. Each component is translated to conformant HTML in a slightly different manner.

The site overview is generally presented as a table of contents with links to the page for each document. The site is also broken down into smaller tables of contents for each named document class. In a typical class, there would be separate tables of contents for guides (tutorial documents), notes, homework assignments, exams, and quizzes. If the web designer chooses, the site can also be presented in syllabus form, using the release date to determine where in a syllabus each component belongs (and prompting the designer whether or not each component type is include).

Each document is presented in two ways. For online use, each document is presented as a simple table of contents with links to the translated nodes. If the web designer so chooses, the table of contents can be in a dynamically expandable form (as in Macintosh System 7's view by name) using automatically inserted JavaScript or VBScript commands. In addition, each document is also presented in a compound form, with each component node on the same page (and their titles at the appropriate heading level). The compound form is primarily designed for printing, although some readers prefer the longer online compound forms, which require less jumping between pages. This compound form also includes a table of contents, which many readers find significantly helpful when navigating the printed version [Krug et al. 1989]. Finally, each document page contains links to the next and previous documents in the site sequence and to their position in the course syllabus.

Central to each node are the title and body (information) of the node, but CourseWeaver supplements these with additional contextual and navigational components. In particular, each node begins with a series of *contexts*—for each document that contains the node, the document name and ancestors of that node within the document are given. In addition, each node also includes a *previous* and *next* links, with one set of links per context. Finally, each node is annotated with *dates* and *version* number (and, if the web designer chooses, links to earlier and later versions).

The initial and terminal contexts added by CourseWeaver help prevent readers from getting "lost in hyperspace" [Nielsen 1995]. In addition, if the web designer chooses, CourseWeaver can add JavaScript code to highlight the current context used, which is determined by the way the document was entered, and is shown by presenting the current context in an alternate typeface.

As an alternate to these many contexts and links, a web designer may choose to have CourseWeaver generate multiple copies of each node, one for each context. There are distinct benefits to this choice. For some readers, the proliferation of contexts may be detrimental rather than helpful. For such readers, a linear structure is preferable to a complex hypertext [Lanza and Roselli 1991]. By making separate copies, the reader only has one path to follow at a time, and it's easy to return to that path if one strays from it. However, multiple contexts may be appropriate for more experienced users, as they not only orient readers, but suggest new paths of exploration.

While CourseWeaver is primarily intended to generate these HTML-based web, CourseWeaver can also build a stand-alone version of a site. This step preserves the overall form of the CourseWeaver structure, but also (1) locks all components (so that students cannot modify them); (2) adds a area for students to take notes on each node; (3) removes some components (all but the selected site, any documents and nodes that are not referenced); and (4) adds context and links (similar to those generated for the HTML version).

Obviously, each web designer will approach web construction in different ways. Some may choose to include different types of documents or nodes, others may wish to use more sophisticated formatting or incorporate Java applets in some pages. CourseWeaver provides four basic mechanisms for generating custom sites:

- prompts for basic decisions (e.g., how to present contexts or how different elements are represented textually);
- a class generation facility, so that site authors may design, use, and share their own classes;
- customizable HTML translation, so that different designers may present elements of nodes in different ways; and
- access to the underlying implementation, so that more sophisticated users can modify CourseWeaver itself.

Comparison to Other Web-Construction Strategies

There are a number of tools that help with some aspects of the construction of course webs, including text editors, page-level authoring tools, translators, site-level authoring tools, and Perl scripts. CourseWeaver's emphasis on logical design and uniform presentation, reliance on a three-level structure for creating webs, and use of a "fill-in" strategy for authoring provides some advantages and disadvantages when compared to these other systems.

Text editors, such as BBEdit [Bare Bones 1996] with accompanying HTML tools [Davies 1996], allow web designers to build templates for their course materials, permitting uniform formatting across web pages. Text editors may also provide tools to automate the insertion of HTML tags, so that web designer need know only minimal HTML in order to create pages and still have great control over their pages. However, many users find it difficult to reformat a large number of pages using text editors, and few text editors provide appropriate mechanisms for version control, automatic outlining, and presenting of information in multiple formats.

WYSIWYG page-level authoring tools, like Navigator Gold [Netscape 1996] and Pagemill [Adobe 1995], allow web designers to construct HTML pages without having to know or understand HTML. . Since CourseWeaver's primary emphasis is on hyper*text* and node-based information systems, it provides only minimal facilities for handling In more complex pages where images or layout are particularly important, the WYSIWYG tools are preferable. However, such tools often provide little help for site-level authoring, for reformatting a large number of pages, or for presenting the same information in multiple formats.

Translators, such as LaTeX2html [Drakos 1995 permit web designers to convert materials generated in other pages to HTML, again, without having to know or understand HTML. Some translators make also it possible to present the same information in different size chunks. However, users often have little control over the translation (which may be based more on the physical layout of a page, rather than the logical layout) and the sites created by automatic translators may be difficult to update or extend. It is also important to note that CourseWeaver does present some translator-like facilities. In particular, each node is automatically translated from text to HTML, with appropriate insertion of paragraph, list, emphasis, and related tags. One CourseWeaver user has found this translation particularly appropriate for translating rough class notes to HTML.

Site-level authoring tools, such as ASML, the Automated Site Markup Language [Frank et al. 1996], facilitate uniform formatting and reformatting for web pages and may also provide additional translation tools and support capabilities (e.g., ASML allows site designers to automatically build multiple search tables containing only part of the site). Many also require authors to learn a new language, which may be difficult for some. For the advanced user, ASML and similar authoring languages have many advantages, as they provide much more control over the structure of the site.

Scripts written in languages like Perl can provide additional facilities, such as automatic construction of outlines. However, they require advanced knowledge to use and reconfigure both the generated HTML and the facilities they provide. CourseWeaver is perhaps weakest on this programmability front, but tries to alleviate some of these limitations by providing access to the underlying implementation.

Finally, full-scale hypermedia authoring systems, such as HyperWave [Maurer 1996] provide extensive authoring, re-authoring, and presentation capabilities. HyperWave, in particular, provides many of the key features of CourseWeaver, including automatic contexts and overviews, some fill-in type authoring, and a class hierarchy. CourseWeaver's primary advantages when compared to a system like HyperWave are its smaller size, its inclusion of predefined templates for educators, and its ability to generate pages whose names have some meaning.

Summary

Instructors creating webs of information for their courses benefit from utilities that automate or simplify aspects of the creation. While there are a number of tools to help authors, each of these tools solves only a few of the problems in creating a course web. While it is possible to use an ad-hoc combination of tools to meet more problems, CourseWeaver provides a single application that is focused on the specific needs of course webs. CourseWeaver not only guides instructors through the creation of webs, but also presents ideas (such as multiple views of the same web for online, off-line, and printed use) that many instructors might not employ without automation.

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HYPERMEDIA SOFTWARE IMPACT IN YOUNG STUDENTS

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Abstract: This paper presents the result of an experiment designed to evaluate the impact of hypermedia software in learning The experiment was carried on with students aged 10 to 11, from three different schools. The experimental design contemplated four groups in each school, 9 students per group, totaling 27 students from each school, and exposing them to courseware about the biology of the human body, either in a full multimedia modality; a linear electronic book format or a printed booklet with the same information. An additional control group received no experimental treatments, but was exposed to the same content materials, through regular classes. The results of the experiment showed that all students increased their retention of information exposed to during training, but the group that was trained through hypermedia software obtained significantly higher scores in metacognitive capabilities such as semantic relatedness and knowledge structuring through a concept mapping task

1. Introduction

The idea that organizing software using a hypermedia based structure can have an impact on student's learning performance is not new. In fact, many authors have suggested that this way of organizing and presenting information enables students to develop search strategies and thereby exercise "higher" metacognitive skills (Engelbart, 1963), enhances the acquisition of conceptual structures (Spoehr, 1994) and allows for self-instruction in a self-paced exploration, according to the users' own interests.

However, there is still a lack of evidence about its real effectiveness and about the areas of its potential impact (Jacobson, 1994). Some authors have addressed problems related to hypermedia such as cognitive disorientation, cognitive overload (in combination with multimedia), inconsistency of links and lack of meaningful links (McKendree, Reader & Hammon, 1995).

In this scenario of pros and cons of hypermedia, the question addressed here is if hypermedia has an impact in the areas of content retention, cognitive association and conceptual mapping. In this sense, we restrict the question of impact to this three specific areas of potential impact.

2. Subjects and Procedure

The main purpose of this study was to investigate whether hypermedia support effective learning. Operationally, the authors explored the effectiveness of a software using a hypermedia based structure, on student's ability to retain a given information, to understand its more complex levels of interrelatedness, and to represent the knowledge structure resulting from its accretion to the students' prior knowledge framework.

These questions were addressed by randomly assigning 5th grade students (ages ten to eleven) from each of three different schools, into each one of four groups of 27 students. All students were exposed to courseware about the biology of the human body, either in a full multimedia modality (Group 1); a linear, electronic book format (Group 2); or a printed booklet with the same information (Group 3). There was an additional, control condition (Group 4), which received no experimental treatments, but was exposed to the same content materials, through regular classes (as did all other students participating in the study).

The participating schools were approached because they had just received a computer lab and the students were naive regarding the use of computers and multimedia educational software. All three schools had more than one class at the fifth grade level; however, a single class per school was chosen to participate in the study, based exclusively on the biology teacher's willingness to collaborate with the study. Once the availability of a given class was determined, up to nine students per school were randomly assigned to each group.

The teacher's collaboration was required in terms of (i) accepting to cover this particular subject area of the curriculum, contemporary to the exposure of the groups in the study, to the different treatment and control conditions; (ii) assigning the students weekly research homeworks based on the material covered in class, thus providing realistic motivational conditions for students participating in all groups; and (iii) relinquishing the control of the class once a week so that the investigator's research assistants could ran the successive 12 weekly sessions that took to complete the study. Because of obvious logistic and procedural reasons, all experimental conditions were ran in parallel, in every school, for all students taking part in a given group.

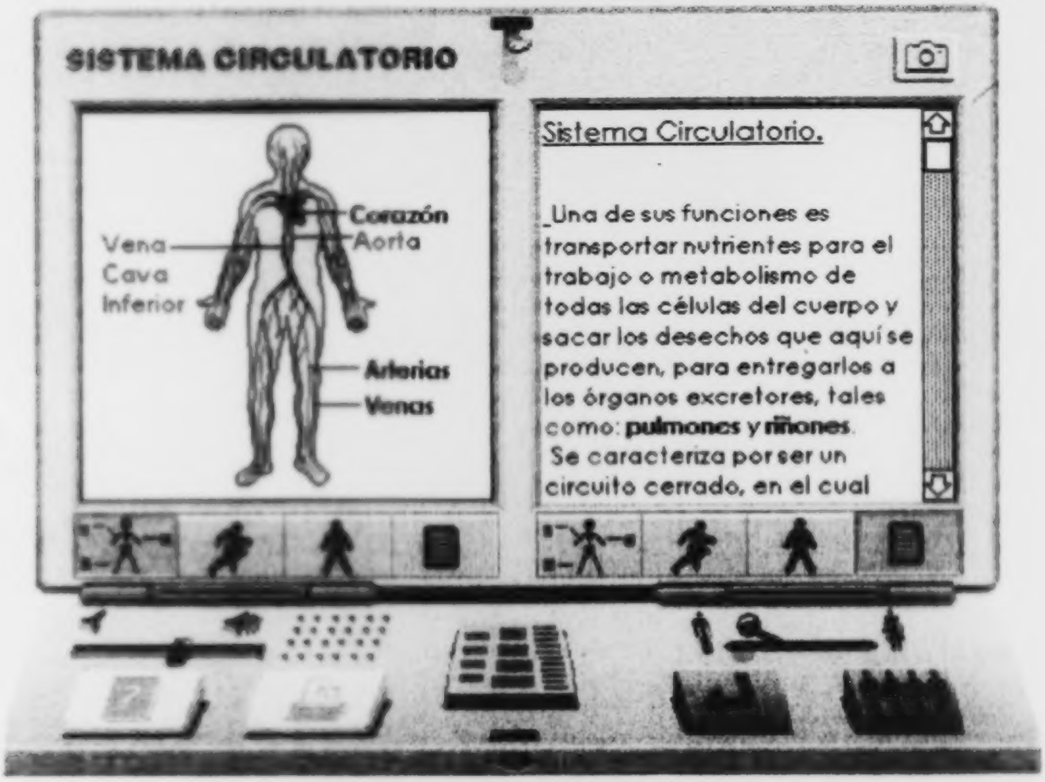
Parallel to this, an agreement had been obtained with the technology coordinator in each of the schools, so that six of the computers in the lab could be used once a week, during the biology class, to work with groups 1 and 2. For this purpose the multimedia version of the software "Centro de Anatomía" (software implemented by the authors) was installed in 3 computers and a version containing a linear sequence of electronic pages of the same content, was installed in the other three computers. Group 3 used a printed version of the latter. Students in the three treatment groups were required to work in groups of three, either in front of a computer, or with the booklet, depending on prior group assignation.

3. Material and Instruments

The software used in the experiment was an adapted version of the software "Centro de Anatomía", which contains text, illustrations and animation about four systems of the human body (digestive, respiratory, circulatory and urinary). The information for each system includes a global description, its principal subsystems and all the major organ of the system. The interface of the hypertext version of the software (Group 1) is shown in Figure 1.

Text and figures contain hyper links to textual and/or graphic information on related organs. The links were implemented following functional (the organ plays a role in the system) or structural (it is a component of the system) relations amongst systems and/or organs.

The linear version of the software (Group 2) had the same user interface, but the links were functionally and graphically disabled (i.e., plain text instead of bold). The paper version (Group 3) was a printout of the text and figures used in the linear version of the software, organized in chapters related to each system.


SISTEMA CIRCULATORIO

Sistema Circulatorio.

_Una de sus funciones es transportar nutrientes para el trabajo o metabolismo de todas las células del cuerpo y sacar los desechos que aquí se producen, para entregarlos a los órganos excretores, tales como: **pulmones** y **riñones**.
Se caracteriza por ser un circuito cerrado, en el cual

Fig. 1: Content Interface of the software used. Main screen of the circulatory system

The Body Knowledge Questionnaire (BKQ), consisted of a set of 40 assertions about parts or functions of the human body, which required a "true" or "false" answer. The test items were built from the same content material included in the software and used during the training sessions. The students' answers to the pre- and post-training applications of the questionnaire were scored using a right or wrong key , previously elaborated by three expert judges.

The Associative Distance Test (ADT), consisted of a set of open questions of the form "Which is the similarity between x and y ?", where x and y were organs or body parts of the same or different systems, which had a relatively closer or more distant structural and/or functional resemblance. The students were expected to respond by specifying those aspects, or dimensions by which, in their understanding, the two elements in the question were related. The assumption behind this questionnaire was that the more distant the elements a student was able to establish a valid associative link with, the greater the metacognitive ability and the amplitude and meaningfulness of the child's representation of the concepts involved. It was further assumed that such sort of abilities would be enhanced in children who had been exposed to hypermedia learning conditions, and therefore, it was predicted that students in Group 1 would obtain a significantly higher score in this test than would students in any of the other three groups. This test was applied once, at the end of the experiment in order to compare post-training performance amongst the groups.

Students' statements in response to the questions in the ADT test were classified according to three different levels of "distance" or abstraction: (a) Concrete responses alluding structural-descriptive features (i.e., "they are circular", "both are microscopic", etc.); which

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were assigned one point. (b) Responses alluding contextual or situational descriptive features (i.e., "...they belong to the same system"; or "...they circulate in the bloodstream"); these responses received two points; and (c) Responses which made correct reference to functional or behavioural similitude across systems, received three points. The highest score empirically reached by one student in the study was 33 points.

A third instrument, designed to assess the richness and meaningfulness of achieved learning through the structure of resulting knowledge, was a Concept Mapping Task (CMT). Conceptual mapping is a technique devised by (Novak & Gowin 1988) in order to facilitate meaningful learning. The same technique, only this time coupled with a scoring system, was used to assess the amount of learning achieved by students in all groups in the study.

Once the treatment phase of the study was completed, all students received three additional sessions to learn how to build conceptual maps, totally unrelated to the subject area of the experimental training. Immediately after this training, students were given a set of 22 labels of concepts related to the digestive system and asked to build concept maps that would depict the structural (spatial distribution) and functional links amongst these concepts. In the CMT, just as had been the case for the ADT, students in each group were asked to work in the same clusters of three children, they had formed during the training sessions. Afterwards, each map was analyzed and scored according to a revised version of the procedures reported by Novak & Gowin (1988). More specifically, the procedure to score the maps was based on the quality of the relations student's were able to build. Hierarchical relations were scored with five points, crossed connections with 10 points and examples with only one point.

4. Results

Concept Retention. Following the application of all measures, data from each test were tabulated and analyzed. The data obtained with de BKQ the the result using t of student test for related data (the same group scored twice), it was found that in all groups there was an increment of retained concepts. As shown in Table 1, Group 3 (paper booklet) presented the higher increment, followed by Group 1 (hypermedia) and the lowest increment was by Group 4 (control). From these results it can be inferred that concept retention will increase significantly, regardless of the treatment modality used to facilitate learning. However, if the percent of increment between pre and post test is calculated, then a notable difference will become apparent.

Group	t	alpha	%increase
1	11,45	.00000	22,88
2	8,50	.00000	18,93
3	19.47	.00000	20,92
4	17,18	.00000	7,66

Tab.1: Student's t test results for pre and post training score comparisons

In spite that all groups showed significant gains in overall retention scores, we observed important group differences in the magnitude of increment of post-treatment scores. In order analyze this issue further, a Pearson correlation was ran between each subject's pre-training score and the percentage of score increment at the second measurement, following training. These data are shown in Figure 2. As it can be seen he resulting correlation coefficients were negative for all groups, meaning that those students who entered the training with lesser knowledge, gained the most. Interestingly enough, Groups 1 and 2, who used computers and multimedia showed this inverse relationship between prior knowledge and training related gain, at a highly significant level (r=-656, p <.01; and r=-678, p<.01, for Groups 1 and 2, respectively).

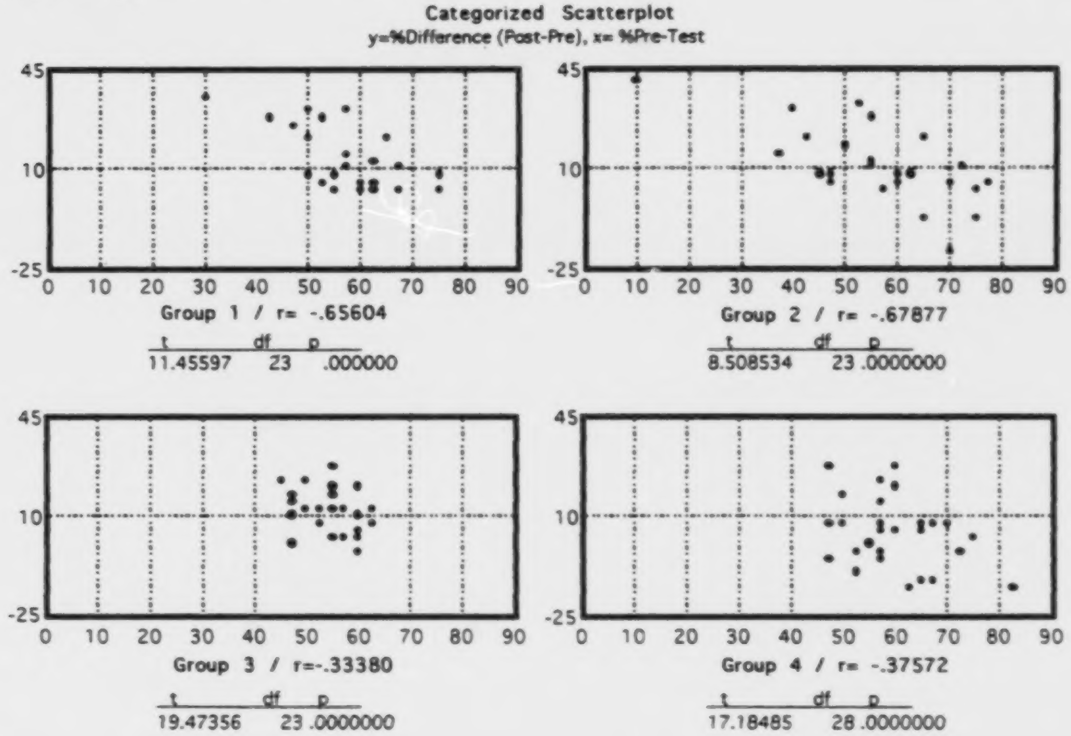

Fig. 2 Scatter plots and correlation between pretest scores and percentage of increment calculated in post-treatment retention scores

Associative Distance Test. The data obtained by the students in all four groups with the ADT test were analyzed by using a one-way Analysis of Variance. The result showed statistically significant differences among the groups [F(3,94)])02.31, p=.04. Specific *a posteriori* contrasts showed that this result was accounted for by the differences between groups 1 and 3 and groups 1 and 4. With this result, we can say that the hypermedia treatment condition, allowed for grater and more meaningful interrelationships of learned information than did the text-based treatment condition, or the habitual classroom activities. However, no significant differences were found between group 1 and group 2, as well as between group 2 and groups 3 and 4.

Concept Mapping Task. The data obtained by the four groups of students in the CMT were also analyzed by performing a one-way ANOVA, which in turn, also showed overall group statistically significant differences [F(3,8)]=12.75, p=.001. Specific *a posterior* contrasts between pairs of means, using Schaffe's LSD test, indicated that group 1 performance was significantly better than that of groups three and four. Again, no significant differences were found between the performances of groups 1 and 2, or that between groups 2 and 3 and groups 2 and 4.

6. Discussion

Preliminary analysis of the results indicate that no significant differences may be found among the groups on the retention of concepts related to body parts and functions. However, the analysis of the percent of gain relative to the level of knowledge the students had on the subject, prior to training, showed that hypermedia software seems to constitute a more powerful facilitator of learning than regular reading or class attendance procedures. On the other hand, it could be said that there seems to be a certain level of knowledge required in order for students to be able to profit by their exposure hypermedia software; and if this level is not present in the user, (s)he will not be able to profit by using the software. This latter notion needs to be tested under lower floor and higher ceiling conditions than the ones used in the present study

On the associative distance test students in group 1 were able to make a significantly greater number of correct far-stretched associations between subtly related pairs of concepts, as compared with students in group 3 and the regular, control group. Interestingly, there were no significant differences between the two software groups (groups 1 and 2). However, the fact that group 2 did not differ significantly from groups 3 and 4, seems to suggest that linearly organized sequences of multimedia based information is not as powerful to promote deep conceptual understanding and awareness of inter relatedness of the learned materials, as does a hypermedia based software.

From a methodological perspective, the question of construct validity (Yin, 1994) is relevant, given the instruments used, were specifically designed for this experiment. This issue is part of an ongoing research, who's aim is to define operational measures for both concepts: associative distance and knowledge and structure. For the time being, and while the instruments results obtained provide a way of comparing the performance between the different groups only.

Related to internal validity (i.e. establishing a casual relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships, (Cone, 1994)) problems like history, maturation and statistical regression are avoided because of the time scale of the experiment (12 weeks only), and problems of testing (effect of the pre-test) were not observed in concept retention. Instrumentation could be an interesting problem, so far the instruments and score methods were invented, but because of the design, this is rather an external validity problem. Problems of selection and experimental mortality were avoided selecting multiple schools and randomly assigning students to each group.

External validity is the most relevant question in this experiment. For example, the difference in content retention between the experimental groups and the control group can be explained by the Hawthorne effect (Cohen, 1994), that is, by the special condition of the experimental groups. Also the results of the other tests must be validated before generalizing. Finding the answers to these issues constitute part of the aims for the continuing research efforts of the authors..

One attempt to prevent this methodological problems, was an attempt to triangulate these data a different set of data captured in each experiment session. Specifically, on every session a log file was automatically produced which indicates the browsing sequence of group one (similar to Misanchuk & Schwier, 1992). This information is still to be analyzed and confronted with the results obtained by each group in the ADT and CMT. In a replica of this study, we hope to find some correlation between the browsing patterns and the associations and the concept maps produced by each student. Since browsing patterns are from each individual and concept maps were built in groups, such correlation was not possible for the present study.

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Making Connections: Interactive Videoconferencing Technology in Distance Education

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Abstract: In the fall of 1995, the Korea National Open University launched a project to research use of the information super-highway with funds from the Ministry of Information and Communication. As a result, an interactive videoconference network was introduced for educational programs in the geographically scattered regional and local study centers. Using this network, the project connected 14 centers, introduced interactive tutorial sessions, held various meetings among university members in different places, encouraged open discussions among students, faculty members, and general citizens, and created non-degree programs using the system. Detailed evaluation has revealed that the majority of the instructors and participants have had a favorable impression of this system. Despite its shortcomings, the investigators have found that VCS is here to stay.

1. Introduction

Most distance learning programs have been delivered in a one-way communication format. Printed materials, audio, video, radio, and TV have been heavily used for delivering the programs. In addition to these media, distance teaching institutes have offered face-to-face tutoring or counselling, e-mail and fax communication services. In recent years, new information technologies(NIT) have exploded and many distance educational institutes have been seeking various ways of incorporating these advanced technologies into their system to improve two-way interactivity and thus to ensure the quality of distance education. This report is based on an evaluation study funded by the Korean Government.

In the fall of 1995, the Korea National Open University (KNOU) launched a project to research use of the information super-highway with funds from the Ministry of Information and Communication. As a result, an interactive videoconference network was introduced for educational programs in the geographically scattered regional and local study centers. Using this network, the project connected 14 centers, introduced interactive tutorial sessions, held various meetings among university members in different places, encouraged open discussions among students, faculty members, and general citizens, and created non-degree programs using the system. Since KNOU serves above 300,000 students and it has 640 faculty members and administrative staff all over the nation, meetings and training sessions among its members were frequently held.

The Korea National Open University(KNOU), one of the world's largest distance learning institutes, was founded in 1972. As the only distance teaching university in Korea, KNOU has continued to serve the advanced educational needs of adults as well as awarding degrees at the bachelor's level to qualified people. As any other distance education institutes, KNOU has adopted printed materials as its main instructional delivery medium and broadcast lectures through TV and Radio as its supportive teaching method. However, most courses require students to attend a one-week schooling session held at the 12 regional centers all over the nation. The purpose of these schooling sessions is to deliver concentrated lectures.

As for the schooling sessions, each regional study center organized the schooling sessions independently from the other centers and thereby provided different contents under the same course titles. Actually individual learning centers hired part-time instructors locally. Most of the time the students in the Seoul area in which the headquarters of KNOU is located received the lectures from the KNOU professors who had themselves developed the textbook materials and examination goals for the achievement tests.

In addition to the 12 regional study centers located in the provinces, 29 local study centers have been established for the students who live in more remote areas. However, to receive schooling sessions, the students who live in remote areas have to come to the nearest regional study center. As a result, there is only limited interaction between students and professors in the regional centers.

Thus the major research questions were as follows:
1. Finding the factors that influence the effectiveness of a videoconferencing system(VCS): What are the instructional tendencies of the professors and interaction patterns during the distance lecturing? What are the satisfaction levels of the distance lecturing and why?
2. Management and hardware concerns: What are the technical problems to manage a VCS and how can it be improved? What kind of future vision do we need to improve VCS hardware equipment?
3. Social and cultural impact: What is the social and cultural impact of the utilization of a videoconferencing system?

2. Interactive Design of the Videoconferencing System(VCS)

From the VCS headquarters, located in Seoul, the VCS is arranged in a fashion that connects 12 regional study centers and 1 local study center. For transmission, a commercial T1(transmission speed: 1.544Mbps) communication line which is provided by the Korea Telecommunication Corporation is used.

The headquarters of KNOU established a studio equipped mainly to broadcast and lecture through VCS. Also, 7 of regional centers have the capacity to give and receive the lectures using VCS. However, the remaining 5 regional centers and 1 local center can only receive lectures since they do not have the ability to broadcast.

Hardware component

The basic hardware components can be divided into five major areas: transmission, video, audio, remote control, and support systems. For transmission a T1 class CODEC(Coder/Decoder), and MCU(Multi Channel Unit) are used. Each classroom is equipped with three color closed circuit cameras, 43" or 52" color monitors, beam projectors, VHS, VTR, and TBC that process the video signals. The audio setup includes a wireless mic system and other audio processing equipment; amplifiers, equalizers and speakers. In addition, a pentium processor PC with all the necessary software is used as the main control station; it is linked to the VTR control and Audio/Video(AV) matrix switcher. As an addional support system, a briefing system and data viewer are designed to create and support supplementary educational materials.

Finance

In 1995, KNOU was designated to be a "Distance Education Trial Institution" by the Ministry of Information and Communication. KNOU with the help of participating industries is in the processing of implementing and conducting a field study on distance education in Korea, which will be completed in 1997. Total amount of $4.325 million was invested.

Educational Scenarios

1. Support of Degree Programs
The purpose of the VCS used in degree programs is to increase interaction between instructors and students, to expand face-to-face leaning opportunities and thus to ensure the quality of distance education. For example, this system can be applied in regular lectures(schooling sessions), special programs such as a summer/winter session, or night school, as well as orientation sessions.

2. Support of Non-degree Programs
VCS can also be used to support various faculty, student, and general citizen activities as well as intra- and inter- school student symposiums, faculty meetings, and general information on education. In addition, the facilities can be leased out to other interested organizations.

3. Evaluation of the VCS

The evaluation of the VCS started in March of 1996 and completed in December of 1996; it is divided into three stages. The first stage, from March to June of '96, involved gathering information on similar cases, preliminary site visitations, the development of questionnaires, and data collection. In the second stage, from July to September of '96, site visitations were conducted, questionnaires were distributed, and interviews were performed. In the final stage of evaluation, from October to December of '96, a detailed data analysis was done. The demographics of the people in this study are the undergraduate students of KNOU, instructors, operators, and managers involved with VCS. In the course of the study, following three different research methods were adopted.

Basic Research: The review of related literature and case studies which focused on two aspects: 1. The effectiveness of VCS related programs. 2. The educational satisfaction and limitations cited concerning VCS like programs.
Field Research: Interviews were conducted and surveys were passed out to the teachers, students, and operators involved in the VCS. Through video analysis and on-site visitations, the actual teaching-learning process were observed and analyzed.
Policy Research: Forums consisting of experts in distance education were open. Through this forum, future plans for improving system stability and availability, teaching strategies, and detailed plans for increased implementation were developed.

4. Results

1. Analysis of VCS's technical aspect revealed the following points. Compared to other distance education media such as audio conferencing, VCS showed great promise and potential as the dominant distance education media. This was largely due to the fact that KNOU's VCS seemed to adequately support a true two-way interactive environment. However, in order to increase the effectiveness of VCS, more technological improvements were shown to be needed. Many technical difficulties from the source and receiving ends were cited to disrupt the VCS session. These difficulties also revealed the need for an adequate back-up transmission system other than the T1 line used for transmission. Some of the technical difficulties influenced the student's and teacher's attitude towards VCS. The unfamiliar environment coupled with these difficulties brought out some people's rejection against technology.
2. In some cases, the support tools used for the production of classroom materials burdened the teacher and was found to be a reason for an unfavorable view on VCS. Therefore, in order to increase the effectiveness of VCS, not only the direct technology involved in VCS must be improved, but also the technology that supports the classroom instructors and students should be developed.
3. Analysis of satisfaction levels and opinions of teachers and students on VCS revealed the following. Although teachers showed great satisfaction in their own teaching strategies concerning VCS, many of them commented on desire for more interaction in the classroom. There were possible reasons for this lack of interaction. However the major reason was thought to be based on the style of lecturing. In other words, the teachers were used to presenting the material in a "one-way" fashion, therefore eliminating from the start any possible interaction from the students. Interviews with the teachers revealed a high level of stress concerning the preparation of the actual lecture and material for VCS. This was viewed to be due to the unfamiliarity of environment.
4. The students generally gave a positive response to VCS, however responded that the VCS lectures were not able to bring much intellectual stimulation and reflect educational diversity. Further analysis of student feedback showed that there was much room for improvement in the operational and management practice of VCS.
5. Further analysis of the social and cultural impact of VCS revealed a favorable response

from both students and teachers. This was largely due to the new opportunities in which VCS offered. The increased availability of experts and different education media seemed to play an important role in this favorable response. Also the time factor, in which the students did not have to travel hours for a lecture, was an extremely attractive trait. This was especially true for the students who were not located near form the KNOU's main campus area.

6. Two main factors need immediate improvement when lecturing through VCS: instructor training and operator training. Instructors who did not have enough training in the VCS were observed to be uncomfortable during their whole lecture. They did not seem to form a close tie with remote students. So, training, not only for the technical use of VCS, but also for remote teaching strategies need be established. Also, many system operators who did not understand the teaching learning patterns did not cooperate effectively with the instructors in delivering the content and did not show appropriate appreciation fo the remote participants.

7. In general, students and instructors wanted more lectures through VCS. Students in the regional and local centers were satisfied because they had opportunities to access live lectures by Seoul Campus professors and hoped that this system would enable them to participate in lectures given by famous experts in various fields. Futhermore, the general public wanted VCS to expand into other general fields like adult education, and extracurricular activities.

8. Social perceptions on VCS were split, however. Where on one side, people hailed it as the next educational medium, others replied that it might be too early to make that judgement. Among these less enthusiastic supporters of VCS, many people commented that VCS was "like watching TV", "boring", and, due to the lack of actual presence of the instructor, that "they felt like they were not in the classroom." Others pointed out their frustration that their so called "classmates" in other regional sites did not "feel like their classmates" for there were few opportunities to interact with them. One of the interesting trends found in the investigation was the participants comfort with VCS largely depended on their view and understanding of the technology. If they were comfortable with and had better understanding of the technological aspect of VCS, they were more likely to adapt to VCS. However, it was interesting to note that, regardless of whether they had favorable impression of VCS or not, many people commented that VCS is appropriate for all educational subjects.

5. Discussion and Conclusion

Due to the exponential growth in telecommunications technology, many new forms of educational media have been made available over the years. One of the most attractive traits of these new distance education media is that they eliminate the spatial limitations of education. In other words, one's need to be actually present at the instructional site is eliminated. Another attractive trait is its affordability. Due to new materials and technology, using these telecommunication alternatives make education more and more affordable. Furthermore, in a world where time has become the most expensive commodity, distance education has also proved to be invaluable. No longer do people have to spend a great length of time traveling to physical locations, saving money as well.

Following the trend to establish more effective distance education media, KNOU, with the help of various corporations and the government, developed its own Videoconferencing System. Detailed evaluation has revealed that the majority of the instructors and participants have had a favorable impression of this system. However, research also revealed that there were several obstacles with respect that VCS must overcome. These obstacles can be grouped into two areas: the technological and the human aspect.

Although VCS proved to be successful in many aspects, the two way communication between instructors and participants must be further improved. Technologically, many students wished that VCS be more user-friendly and less intimidating. Sometimes even when a query was made by a participant, due to mechanical or technical difficulties, the query was lost or delayed. Both instructors and participants commented that "they weren't getting the full view" of the classroom indicating that more coordinated camera movement or monitor arrangement needs to be worked out.

This study has also revealed that if VCS is to become even more successful, proper education of VCS technology must be given not only on the participants but to the instructors as well. It has been noted that many people "sensed" that some instructors were also uncomfortable with the environment, thus, bringing down the credibility of VCS. Although technology can never replace the personal aspect of education, we believe a more personal atmosphere can be created through proper orientation and curriculum development.

VCS has shown its strengths and potential to become one of the most powerful education tools in the near future. Through this study the investigators have found that VCS is here to stay, despite its shortcomings.

Tele-Educational Services in a Future Open Service Market

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ABSTRACT: Changes in the telecommunications industry are now allowing support for cooperative provisioning of multimedia tele-services. This can provide a useful model for educational organizations to handle the inherent complexity of providing tele-educational courses while leaving them time to concentrate on pedagogical issues. The Prospect project is examining the provision and management of tele-educational courses involving multiple multimedia services offered by many service providers. The paper presents the model as it applies to tele-education and presents some preliminary findings.

1. Introduction.

Internet technology is currently having a significant impact on work methods and practices as evidenced by the rise in tele-working, WWW based commercial advertising and the proliferation of commercial services offered over the internet. In distance education, email, file transfer and WWW based technologies have been used for the distribution and delivery of education material. However, up to now most web-based distance education has focused on asynchronous educational material. In these cases the course material is available on the web with e-mail or other asynchronous communication methods used for student/teacher or inter-student interaction. Given the tools available for creating such Web-based course material it is feasible for educationalists to create their own materials and to offer courses over the WWW or intranets in a relatively straightforward manner.

Unfortunately, such asynchronous approaches can only support a small subset of educational experiences. Given the need for a rich educational experience, increasing use of synchronous and mixed mode technologies are envisaged in the future. This is likely to increase significantly [Riordan 96] the amount of technologies which must be mastered in order to create a tele-educational course. It is unlikely that educators will be capable of, or even desire to master all of these technologies in addition to their own specialism. Therefore, there is a need to allow educators concentrate on the pedagogical issues. Further, it is unlikely that one technical organisation will be experts in all the technologies required to support rich educational experiences.

The Open-Service Market for telecommunications services envisaged for Europe and other world regions (the so-called Global Information Infrastructure - GII and European Information Infrastructure - EII) can significantly assist such a scenario by facilitating multiple service and (educational) content providers to cooperate in the provision of a single educational course. Such educational courses would not be limited by state or country boundaries. In addition, consumers of educational courses may have the opportunity of choosing between the offerings of multiple service providers.

The Prospect project [Wade 96] has been examining the issues which would be involved in such a marketplace. The consortium has made significant progress in specifying and implementing technology and trials of pan-European educational services and technologies. In particular, several tele-education courses have been developed which are to be offered as part of a pan-European trial of the Open-Service Market to take place in March 1997. The distance education courses have been designed to illustrate the use of different modes of teaching. This paper begins by examining the idea of an Open Service Market and the influences and opportunities such a market could bring to distance education and training. Section 3 illustrates the complexity and multi-modal nature of tele-education courses. Section 4 describes the two tele-education courses which will be offered to students as part of the Prospect trial. Finally Section 5 draws some conclusions from the work carried out to date.

2. Open Service Market for Tele-education

Traditionally telecommunications has been an area dominated by large national providers who managed their own resources and whose management technology existed as tools for their own operators, rather than being available for use by their customers. In addition as there was insufficient standardisation, there were many proprietary technologies involved. However recent developments have seen new customer requirements and deregulation of the telecommunication industry [EEC 90] result in services which have to be offered in a highly competitive environment [Wade 97]. Individual services will be designed to meet the needs of specific market sectors and customers. Customers will demand access to their own range of services independent of traditional country and network operator boundaries. This means that public services must be offered in an international manner and presented to the customers in a uniform way, i.e. a common look and feel, independent of the location of the service provider. The distinguishing characteristic of the foreseen future telecommunication service environment is the existence of several competing service providers who are forced into co-operative activities due to customer requirements such as one stop-shopping and global scope of telecommunication services. This environment is termed the *Open Service Market* (OSM).

In parallel to the development of broadband networks new multi-media end systems are being developed which enable the generation, compression, transfer and display of streams of digital video and audio. These range from low cost end systems (e.g. set top boxes or simple network terminals) up to high performance workstations. These are typical application areas where various services will be provided at different costs and with different modalities of use. The rapid development of computing and telecommunications technology affecting networks, end-systems and services are being accompanied by an opening up of telecommunications markets to greater competition. Consequently, an open market of services will develop where public and private organisations will compete in providing and using basic and value-added services. Nevertheless, significant problems in multi-media service provisioning, co-operative management, accounting, billing and security are not solved yet [Hall 96]. Constraints of the technology used in the Internet will limit its growth in terms of network capacity, multi-media services, security, customer query and control and inter-domain management.

Applying the Open Services Market to tele-education, a wide range of multimedia tele-services could be combined in several subsets to support educational teaching and instruction modes. This would allow general purpose tele-services to be provided by multiple providers. Value-added service providers would then customise and combine these tele-services to target particular markets. The Open Service Market scenario where the software environment is delivered over a computer network on each occasion of use, allows a tele-education service to be offered on a "when needed" basis and for charging to be limited to the use made of the service. Alternatively more conventional charging models are also possible [Yourdon 96]. This allows much greater scope for customisation of the service delivered to the user.

The Prospect project has chosen such a tele-educational scenario as a basis of its trial. Prospect has implemented several multimedia services (video/audio conferencing, interactive hyper media services, and Webstore) which are integrated on the desktop of teachers and students to provide what Prospect terms the Prospect Tele-Educational Environment. Each service is offered by a different service provider, with a value added service provider (tele-educational service provider) acting as the single point of contact with end customer organisations. In order to provide the connectivity required for such services, Prospect also includes a Virtual Private Network (VPN) service provider who offers network connectivity across different public (national) network operators broadband ATM networks.

As has been pointed out, Prospect is not dealing here with a conventional software application but instead with a network-delivered service. The implications of this are the existence of multiple stakeholders which must be considered fully in the design of the system. In order to trial tele-education solutions in an Open Service Market the enterprise model depicted in [fig. 1] was adopted from among a number of possible variants. This model defines the stakeholder organisations which play a part in developing and using such a tele-education service. It also identifies the roles of stakeholders and their contractual relationships.

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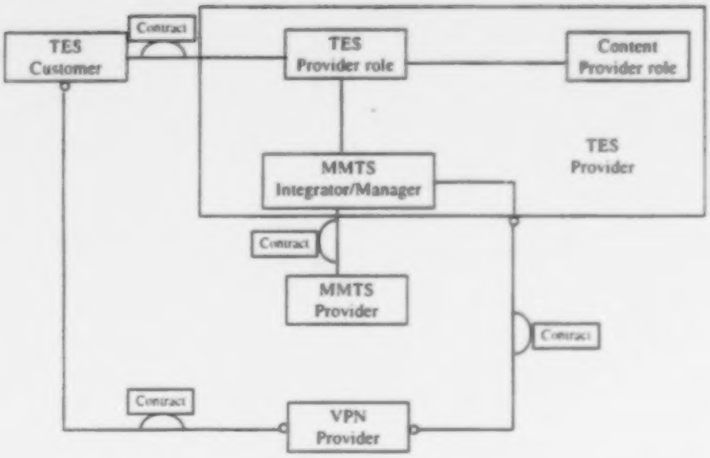

Figure 1: PROSPECT Enterprise Model

- Tele-education Service (TES) Customer - The end-user organisations of the tele-education services.
- Tele-educational Service Provider - The organisation which provides the tele-education services and who combine various multimedia tele-services along with appropriate content to support participants on a course.
- Tele-educational Content Provider - development of the educational content. This can be done by the TES provider or it can be out-sourced. The above enterprise model captures the requirements of both situations.
- Multimedia tele-service (MMTS) Integrator/Manager - will integrate tele-services and their management. This can be done by the TES provider or it can be out-sourced.
- Multimedia Tele-service (MMTS) Providers - These are the organisations which provide general purpose multimedia tele-services such as hypermedia delivery and multimedia conferencing. Their contractual relationship would be with the TES provider and not the end customer.
- Virtual Private Network (VPN) Provider - The provider of the transparent integration of bearer services (pan-European network). The VPN supports one-stop shopping and integrated billing for the network services.

3. Features of an advanced Tele-education Course

In order to illustrate how an Open-Service Market can be of benefit in the creation and operation of tele-education courses a model describing the organisation of Prospect tele-educational courses has been developed. It identifies the generic stages within a course and describes the forms of interaction between participants (tutors and students) and maps these interactions at the various stages of a tele-educational course onto possible communication/mediation mechanisms. Several forms of learning have been identified which the Prospect Teaching environment wishes to support. These learning forms are:

1. *Self Learning* - delivery of formatted course material for students own study.
2. *Lecture Presentation* - a one-to-many presentation by a tutor of course or organisational material.
3. *Exercises* - the facility to perform exercises either in groups or individually.
4. *Project work* - the development of sizeable projects using software outside the teaching environment.
5. *Discovery/Reference Search* - ability to locate and access background or supplemental learning material.
6. *Seminar / Class Discussion groups* - many-to-many communication between participants.
7. *Consultation* - private one-to-one communication between participants.

There is some overlap between these learning forms e.g. exercises, project work and discovery/reference search can be part of the self learning form, but all of the learning forms are listed here for completeness. To support the learning forms for the first Prospect, three partners acting as MMTS providers have implemented a multimedia tele-service each, providing both core and management services. The multimedia teleservices are briefly described as follows: *Video/audio conferencing service* - based on the MBONE tools VIC (video conferencing) and RAT (audio conferencing) [MERCI 96]. This service supports conferencing via IP multicast routers and in Prospect management of subscription to the service and accounting of the use. *Hyper media service* - allows access to be provided to hypermedia information stored on a WWW server. *Webstore service* - a managed WWW based multimedia document store, which allows users to store and retrieve arbitrary documents (text, video, audio, etc.) , using the well-known interface of the WWW. The management of the Webstore includes subscription, accounting and access control.

A mapping between the learning forms and the multimedia teleservices has resulted in a list of four basic paradigms:

Self study - individual work with web based course material including exercises and discovery/reference search. This paradigm is supported by the hypermedia and webstore services.
Lecture - teacher to class presentation supported by the conferencing and hypermedia services.
Group work - discussions, exercises or project work performed by the students in groups. This paradigm can also include shared discovery/reference search. It is supported by conferencing, hypermedia and Webstore services.
Consultation - student to tutor consultation. Supported by video/audio conferencing and hyper media services.

In order to support these four paradigms the multimedia services are integrated into a tele-educational service (TES) which provides both the core service and the management service functionality. The core tele-educational service provides two user interfaces, one for the teacher and one for the students. These integrate the underlying multimedia tele-services and add some educational specific functionality to the service, including control of which learning paradigm to use, means for the teacher to present "slides" for the students and automatic correction of small exercises in the self study module. The functionality of the service changes during a course session, according to which of the learning paradigms is used. An example of the user interface for a student doing group work can be found in [fig. 2].

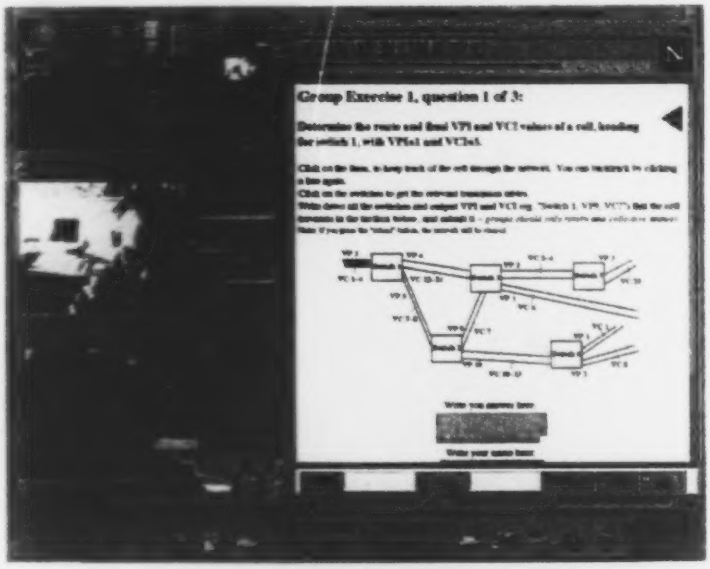
Group Exercise 1, question 1 of 3:

Figure 2: Students screen during group work

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For the management part of the integrated system two user interfaces are provided. The tele-educational service provider administrator user interface providing means to administrator subscription of the tele-educational service and accounting for its use. For the customer administrator another interface is provided to enable administration of users. Both interfaces are Java stand-alone applications. The following functions are provided:

To the tele-educational service provider administrator:

- controlling subscription of customers
- query information about subscribers, subscription contracts and service profiles
- management of users and network access points
- query information about users and network access points

To the tele-educational service customer administrator:

- management of users and network access points
- query information about users, network access points and subscription information

4. Example Tele-education Courses

Two courses are provided for the first Prospect trial, both offered by the same TES provider, but developed by two different partners acting as tele-educational content providers.

Course 1: An Introduction to ATM: The course "An Introduction to ATM" provided as part of the Prospect trials includes both synchronous and asynchronous delivery methods. The duration of the course is four days with approximately three hours of teaching and studying each day. It consist of five lectures (one each day plus a plenary discussion at the end of the course), three self study modules and three group exercises with a follow-up discussion of the results. The different modules of the course are wrapped in a tele-educational environment which also includes course outline information, a database of participants with pictures and CVs, a WWW billboard supporting off-line discussions and a tea-room which participants can "visit" for informal "chats". The lectures are performed by use of video/audio conference with use of a system to show slides on the participants web browsers. The self study modules are web pages with information to read and small built-in exercises. The group exercises consist of a number of questions to be answered by the group and thereafter returned to the teacher for correction. When the teacher has corrected the answers they are discussed in a conference with all the participants.

Course 2: An Introduction to Relational Databases and SQL: This course is designed as a self contained, self-learning course. The course is for use by a large number of students (typically about 100 to 200 students concurrently accessing the course over a one month period). The course is presented in a sequence of modules each with a specific pedagogical goal and with self assessment questions to give feedback on the students understanding and comprehension. The multimedia course material integrates textual, graphical, animation and user interactions to provide as much student participation and stimulation as possible. The tutorial style questions in each module involve the student entering both free text answers (form based) as well as multiple choice questions. As the design of the course material is modular there are several "road maps" available which support differing profiles of educational experience and bias e.g. naive user, experienced user or database programmer. The idea is to provide various navigation paths through the modules based on the different level of knowledge of student groups. A teaching support service is also provided to facilitate any user queries or problems that may arise during self study activities. The teaching support service is also involved in correcting exercises submitted on-line and in providing feedback to the students. In order to provide further stimulation of the student in the educational course, student-student and student-tutor communication is facilitated by and integrated video conferencing, audio conferencing tools. To successfully put into practice the material presented on the course, access to live commercial databases are also facilitated. Such access provides a powerful means of reinforcing the principles and techniques presented in the course. This also provides a means of allowing the student to build large project based assignments, both individually and in group projects, which provide more focused practical experience for the students.

5. Conclusions

An Open-Service Market can provide a broad range of tele-services which can then be combined to support a range of educational experiences. The Prospect project is examining how this might happen by developing service management technology and conducting trials across a pan-European ATM network. This paper illustrates two courses which are being provided during the trials. These illustrate the capabilities and versatility of the approach. A major question to be answered is how feasible is the cooperation required in model. To date Prospect has found this to be manageable given use of appropriate interface definition technologies such as CORBA. In addition the project has found that students find the learning experience very beneficial although further studies are required on this. Also participants were very happy with the flexibility offered by the courses. Problems which arise are dealing with Human-Computer Interaction issues in a multi-service provider environment and also the need for tools to support the various stages of service creation and provisioning. Lessons learned to date have been requirements for a logical structure to all course material rather than excessive use of hyperlinks, the amount of time it takes to develop the course material, the need to provide students with feedback, limit amount of content per page, provide responses to student queries in a timely manner.

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Implications of Distance Education as an Agent of Sociocultural Change

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Abstract: Inherent in all theories of education and training are overt schemes for the design and promotion of change. In general and at the level of surface formality, the target for change efforts is the individual learner. What is often neglected is an awareness of additional changes that may be wrought on the sociocultural fabric of the culture within which the learner is embedded. The language, content and instructional design of exported training and education programs all convey subsurface value structures characteristic of the culture of origin. This paper examines the possible effects that Western educational history and individualistic perspective may have on non-Western and non-individualistic cultures. Included are recommendations for culturally informed progress in the field.

As distance education permeates national and cultural borders, we become agents of cultural diffusion and change. The distance education literature is beginning to acknowledge the cultural implications of what we are doing in the field and the potential for sociocultural impact. To make our way through the various treatments requires an understanding of the meanings of philosophical constructs such as modernism and post-modernism, Fordism and post-Fordism, globalization, consumerism and democratization. The current literature on the cultural implications of distance education describes these concepts and forms a foundation upon which this paper is largely based (Evans, 1995; Field, 1995; Edwards, 1994; Moore, 1994). This paper synthesizes and applies what has been written on the topic and extends the boundaries of current discussion.

This paper has been structured into three parts. Part one discusses aspects of our sociocultural heritage typically overlooked in the written histories of the field. The purpose will be to illustrate the importance of recognizing our roots in the Western history of education and communications technology so we can arrive at a more complete understanding of our potential to alter culture. The second part of the paper will examine how the consideration of the specific cultural dimension of individualism - collectivism may be relevant to our theory and practice. In the final segment ideas and suggestions for developing a self-reflective, culturally sensitive and sustainable distance education model will be proposed.

The Missing History

The field of distance education is considered to be a very young and emerging sub-discipline in the larger field of education. It is not uncommon to encounter historical descriptions of distance education that begin with the description of self-study programs used in the first half of the 19th century (Moore & Kearsley, 1996). Historical accounts in the field tend to focus on the "distance" aspect which distinguishes it from traditional educational programs. An implicit assumption seems to be that practitioners and students in the field are aware of the much deeper historical and philosophical origins of education in general. This assumption has allowed those engaged in the preparation of professionals entering the field to skip or gloss over an essential historical aspect necessary to instill a more complete awareness of the potential sociocultural consequences of distance education.

Formal education has been engaged in the process of cultural reproduction, innovation and diffusion for centuries. Schools in Europe during the 15th and 16th centuries served the purpose of supplanting folk-ways of knowing and traditional networks of communal knowledge sharing. Schools introduced and promoted a new rationalism that denied legitimacy to the culture of the common people while beginning to build a cultural foundation upon which the modern nation could be constructed (Martin-Barbero, 1987). We witness, at this early stage, the ideological potential of education to support the installation of new dominant paradigms and altered cultural dynamics.

The ideological power of education can also be appreciated by examining the role of education and schooling during this century. In the United States the form and function of the public education system was influenced by a myriad of business, religious and political special interest groups (Spring, 1992). It is no accident that the public school resembles a factory in which the compliant worker-consumer is the end product. Together with the culture industry and trans-cultural corporate interests, institutional education is an essential feature of current patterns of sociocultural dominance and compliance.

Distance education is fundamentally and primarily an institutionalized form of instruction. What makes it different from traditional education is not a unique historical origin but an amplified ability to access large numbers of individuals and to transcend traditional barriers to communication. This distinguishing feature exists due to innovations in the technologies of transportation and communication. By recognizing this feature we arrive at another culturally relevant aspect of distance education, its reliance on modern forms of communications and media.

Mass media also comes to us with a historical legacy. Every technological revolution in communication has increased the power of the author, speaker or actor to gain the attention of multitudes spatially and temporally distant (Carley, 1995). Among the many cultural consequences has been the creation of a discursive space between the traditional cultures of the 'developing' world and the encroaching cultural form of the economically dominant. In a discursive process cultural norms and value structures are negotiated to the point of a compromise between the cultural demands of the traditional and those of the domineering.

The massification of culture and the increasing power of modern communication technologies have changed the way in which we conceive of ourselves and culture. Traditional cultures can be eliminated, assimilated, altered or commodified depending on the nature of the specific discourse between the target culture and the relevant embodiment of hegemony. In all cases, cultures change and individuals become compelled to redefine themselves.

By recognizing and claiming a more complete conception of our origins in education and mass communication we can begin to appreciate the importance of considering the sociocultural meanings of our decisions. By taking a deeper historical perspective we are provided with some clues as to the possible directions we might be heading. With this in mind, we now turn to examine one cultural dimension and to explore the way in which it might be effected by distance education.

Individualism - Collectivism and Distance Education

One feature that is common to all cultures is the existence of value structures. Value structures are abstract constructions that are diffused throughout cultural systems and are used by individuals to interpret behaviors. Value structures often become most obvious when they are employed to evaluate the behaviors of individuals who do not share them. Since value structures are deeply embedded within the psyches of members of particular cultures they are frequently used, in this way, without an individual's awareness. Prejudice, xenophobia and many common misunderstandings are due to the differences in value structures of interacting individuals from different cultures.

Attempts have been made to describe and compare the features of value structures of different cultures (Hofstede, 1991). The result is a growing collection of cultural dimensions that are most often correlated with nations (Smith, Dugan & Trompenaars, 1996). One commonly referenced dimension is individualism - collectivism.

An individualistic culture is one in which the individual is the focus of activity and meaning. Success in such a culture is perceived to be dependent upon the hard work and commitment of the individual to achieve. In such a culture a person's value is assigned more on their individual merit rather than any family or group connections. In the individualistic culture the individual's sense of self is largely created and maintained within their psychological structure.

Collectivistic cultures are characterized by the primacy of the group. The individual's self-identity is largely dependent upon the sense of belonging to groups which can include extended family, teams, neighborhoods or tribes. Success is more often dependent upon inter-group and interpersonal connections rather than individual achievement. In collectivistic cultures individuals are more likely to sacrifice individual self-interest if necessary to maintain harmony and promote the interests of the group.

The individualism - collectivism dichotomy can best be thought of as a continuum. All cultures have individualistic as well as collectivistic tendencies. The results of research conducted in this field are presented by arranging national cultures at various points on the continuum. National cultures which tend toward the individualistic end of the continuum include the United States, Australia and the countries of Western Europe. From Hofstede's work we find that the countries occupying the opposite range of the continuum are Latin American and Asian countries typically described as "developing" nations (Hofstede, 1991). There have been few studies conducted that give much of an indication of the position of African and Middle Eastern countries so the clustering along the continuum does not provide a comprehensive world view with regards to this particular cultural dimension.

The sociocultural contexts of the economically and technically dominant nations of North America and Western Europe represent the birthplace of distance education. As an institutional embodiment of cultural values, distance education carries the individualistic characteristics of this genealogy to an apogee. In distance education we talk of the shift of the center of the instructional transaction from the point of delivery towards the learner. The most successful distant learner is thought to be the *independent* learner who is able to tap motivational and metacognitive resources lying within themselves.

This bias of distance education toward self-motivated and independent learners has been suggested to represent a form of academic sexism in its disregard of the differences between women's and men's ways of knowing (Kirkup and von Prummer, 1990). One of the primary differences may be thought of in terms of the relative positions of men and women on the individualism - collectivism continuum. Women are thought to demonstrate differences in value structures and learning styles suggesting a greater degree of collectivism than men. Kirkup and von Prummer challenge the current conceptualization of distance learning to honor the needs of women students by expanding opportunities for social connection and interaction in the learning process. In their conclusion they state:

> *It would not be educationally justifiable to encourage these women to adopt attitudes to study similar to those of their male colleagues, but in many cases the opposite would be quite in order* (Kirkup and von Prummer, 1990).

What the Kirkup and von Prummer study demonstrates is the exclusionary potential of a distance education model that disregards the cultural differences between men and women learners. They also suggest that the practice of distance education would be improved if we paid more attention to women's ways of learning.

We can use their findings to anticipate sources of conflict and dominance that may occur with the internationalization of distance education. In thinking that distance education, as practiced in the individualistic cultures of the dominant nations, is exportable to the collectivistic cultures of the developing world we must embrace the historical ethnocentricity of our sociocultural ancestry. If we are to rise above our own ethnocentricity then we need to think and work in radically different ways.

The Challenge of Developing a Culturally Sensitive Distance Education

At this point in the development of international collaborations in distance education we are in a position to effect the nature of the new discursive space that is being created. We need to move beyond our cultural and theoretical boundaries if we hope to develop and implement models of distance education that go beyond the limits of our own history. Saba (1994) addresses the need for moving beyond the traditional unidirectional form of the international development discourse. He suggests that Systems Theory may be of some use in guiding us toward new ways of conducting intercultural distance education projects.

An essential step required for the development of an international distance education model that honors cultural differences is to seek guidance outside of our own individualistic cultures (Moore, 1994). Gayol (1994) identifies unequal partnerships and stereotypical cultural views as two constraints on the development of successful international collaborations. She points out the inherent and asymmetrical nature of power dynamics that frame international discourse around distance education. She also describes how prejudice and xenophobia come into play as we begin to interact with an "other" that is internally defined by the images presented by the mass media and racist mythology.

Ways by which the social values of cooperation and solidarity may be incorporated into a distance education program are suggested by Murillo (1994). At the Universidad Estatal a Distancia, in Costa Rica, a conscious and programmatic effort is made to counterbalance the extreme individualism manifested in distance education. The content of the materials and the structure of the educational experiences are both designed to honor the traditional values of service, personal sacrifice, cooperation and solidarity. The efforts being made in Costa Rica can provide us with models and innovative perspectives that allow us to get out of our own cultural cages and design distance education for social humans.

Conclusion

As distance educators we need to be aware of our role in changing culture and establishing the terms of an emerging global culture and to take our responsibility as agents of change very seriously. It is possible to involve ourselves in trans-cultural educational discourse in ways that honor the traditional cultures of the world. Rather than assuming that our cultural point of reference represents the ideal conceptualization of education we need to embrace the values of the cultures with which we become engaged. We have much to learn from the collectivistic cultures of the developing world. Traditionally marginalized populations within our own cultures can be better served by new forms of distance education that incorporate the wisdom of the collectivistic value structures.

From the discourse established in trans-cultural educational interactions we can support the emergence of a global culture that embodies the best of many worlds. In fact it is our obligation to do so. It is insane to think that the extension of Western habits of consumption are sustainable on a global level. There are limits to how far the consumerism of our cultures can be extended. We need to begin to consider models of distance learners outside the constraints of an individualistic paradigm.

In order to achieve culturally responsible growth in the field of Distance Education we must raise and pursue new questions in our research and practice. The following questions are some examples of places to begin a new focus of study:

- How can we facilitate two-way intercultural interaction?
- What aspects of our own sociocultural heritage are most likely to deny the values of others?
- In addition to individualism - collectivism, what other cultural dimensions may be directly or indirectly effected by the diffusion of the knowledge we present and the way in which our learners are expected to access and apply what they learn?
- What happens in culture when boundaries, norms and values are challenged by changes in the educational level and global awareness of the populace?
- What are the deeply-situated assumptions and values on which our theory and practice rest?

These questions, and certainly others, should be used to guide our self-reflection, research and practice in the field of distance education.

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Phenomenology, Cognition, and the Design of Interactive Learning Environments

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Abstract: Interactive learning environments (ILEs) in education have received a lot of attention during this past decade. However, many ILE products for the educational market are little more than animated books. More so, some ILE products make it more difficult for students to access the very resources they need for learning important scientific practices. This paper argues for a different approach to the design of interactive learning environments, their human-computer interfaces, and their contents. In this approach, which is based on a phenomenological perspective of human cognition, designers begin with the worldview and discourses of future users rather than with their own conceptions of how the world looks like and works. Rather than thinking of ILE packages and their interfaces as information providers, this paper proposes to think of them as interfaces as tools and as sites for the emergence of culture through human-human interactions.

1. INTRODUCTION

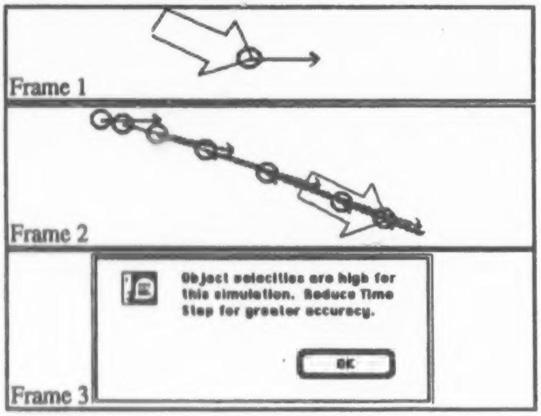
Many teachers and sales persons of ILEs stress the function of their products in terms of the information accessible. However, studies showed that even with the most sophisticated help systems, there are breakdowns in human-computer interactions that cannot be solved by users themselves (Ehn 1992, Roth Woszczyna and Smith 1996, Suchman 1987). To introduce the problematic issues, let us consider a "user-friendly" simulation program, Interactive Physics™, used in many physics classrooms around the country.

The three students in the following transcript[1] completed several assignments using a Newtonian microworld that allows users to model physical phenomena by integrating real world-like events, for example the motion of balls, and diagrams which are characteristic of canonical physics. After setting up a physical situation, a "run" button lets users observe the effect of the ball under the established conditions.

Students' present assignment asked them to explore the meaning of the arrows and provide observational and theoretical descriptions for them. Here, the three students set up (Frame 1) and ran an experiment in the microworld. After the ball raced off the screen (Frame 2), a message indicated that "Object velocities are high for this simulation. Reduce time step for greater accuracy" (Frame 3). Randy read this message almost under his breath and Linda asked for the referent of "time step" (Frame 4). First Randy then Gaalen suggested that the big arrow was time step (Frame 5).

Gaalen: OK, now run it.
Randy: Right. PUSHES RUN BUTTON
(0.8)
Gaalen: Ho:::leeee.

Baby! Yes!
Randy: [°Object velocities are high for this simulation. Reduce time
[HITS OK BUTTON



Object velocities are high for this simulation. Reduce Time Step for greater accuracy.

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[1] The following transcription conventions were used: (0.8) = pauses in tenth of a second; PUSHES BUTTON = words in small caps indicate actions; ::: = lengthening of phonemes; [= indicates start of overlap with previous utterance; °object° = words and sentences between degree signs are spoken with very low volume, almost inaudible.

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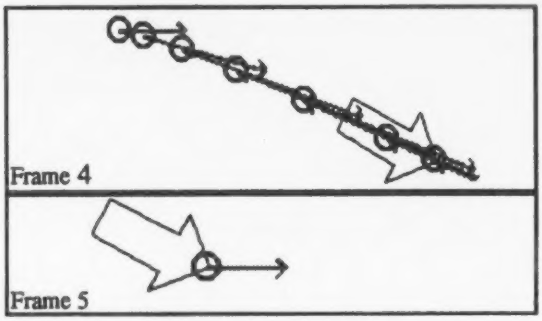
step for greater accuracy°
Linda: Which one's the time step?
Gaalen: ['K, reset
[HITS RESET BUTTON

Randy: It's that big arrow
Gaalen: Oh yeah the big arrow's time (0.9) 'K (1.4)
the big arrow's time



If the designers or the students' physics teacher had listened, they would have noticed that the students' interpretation of the big arrow was not time at all.[2] That is, students read the feedback message, but they read it in a way that was incompatible with the way the designers and other competent users of the system would read the message. It is therefore important to note that (a) the moving objects and arrows did not provide students with unambiguous information about the physics of motion and (b) the messages intended to provide users with help in their negotiation of the learning system were understood in a way that, at this point in time, impeded with learning. In this situation, the "information" was not that intended and therefore not information at all; the help system was not that intended and therefore no help at all.

Rather than viewing this interface as an information provider about physics, we can also take a tool perspective on this system. In this case, Interactive Physics™ is a tool for exploring and learning physics. As we saw, the three students did not use this tool in a transparent way. It was not *ready-to-hand* but obtruded and interfered with learning. When tools begin to interfere with our using them, they become *present-at-hand*. In the case of these three students and their peers who worked on other computer stations with the same program, there were many occasions that forced them to investigate the tool rather than the physics they were supposed to investigate and learn. That is, *breakdown* had occurred and learning did not proceed in the way intended by the teacher. Rather than learning physics, students spent a lot of time learning to handle computers, interface, and program.

Recent work on the design of human-computer interfaces suggests that the problems outlined in the above example are inherent in top-down approaches of most design (Ehn 1992, Winograd and Flores 1987). Most human-computer interfaces are not designed for breakdown but rather cause it. These and other authors suggest taking new and different approaches to the design of interactive learning and work environments; these approaches are particularly concerned with the way we experience our world and on the relationship between language and experience. They are also designed based on a different view of human cognition. To understand the nature, efficiency and rapidity of human actions, researchers now consider how intelligent behavior arises from the engagement of the individual with structures in the world: they consider the fundamental condition of any agent as *being-in-the-world*. As the hyphenation indicates, humans are considered an integral part of the situation in which they find themselves. Cognition is distributed across social, material, and historical aspects of the situation each in turn depending on the situated interpretation of the agent (Dreyfus 1991). Much of this work in cognition and learning has been influenced by Heidegger who thought of human activity in terms of shared social practices. All current social practice theories of knowing, learning and understanding take some element from the work of this philosopher. This includes the pivotal role of language in structuring our experiential world, the absence of explicit symbolic re-presentation[3] of contexts and tools during competent action, and the role of communities as resources for individuals' *concernful* actions. The purpose of this paper is to show how the work of Heidegger encourages us to change our thinking about interactive learning environments and learning at and with human-computer interfaces. Such a change in perspective gives rise to concomitant changes in the ways we (a) design interfaces and the contents of ILE products and (b) conduct research about learning in the presence of computers.

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[2] In simulations, the calculation of the path of a moving object involves velocity and time; thus, the object moves along a straight line for a short moment, the length of the time step, and reaches a new position. Here, acceleration and hence velocity of the object are recalculated. The new velocity is used to led the object move ahead on a straight line to the new position. And so on. If the velocity or the time step are high, the calculation of the path becomes so inaccurate that the model no longer predicts the actual paths taken by moving object.

[3] Re-presentation and re-present are hyphenated to make readers constantly aware of Heidegger's (1977) fundamental point that our ideas about things are not the things themselves. The German word for re-presenting, *Vorstellen* (literally put before), connotes that the thinking person puts the contents of thought before him/herself. But it is through re-presentation that we detach ourselves from the basic mode of being and separate the knower and the known.

2. PHENOMENOLOGY OF COGNITION

The fundamental mode of existence is being-in-the-world (Heidegger 1977). That is, in most situations we do not carry around cognitive models of ourselves and the world around us, but take them for granted. Normally, we do not re-present the world in some abstract sense with objectively-specifiable aspects and properties. For example, when I want to write an article or paper, I sit down at my computer and do it. I start up the word processor and write about the phenomenology of cognition without having to think about the computer, word processor, keyboard, and so forth. I take all these for granted and focus on the piece I decided to write. Unless something goes wrong, that is, during breakdown. In cases of breakdown such as the absence or malfunction of a keyboard, we begin to actively formalize, re-present, and categorize particular parts of the world.

When we begin to formalize, re-present, and think "rationally," we do so based on our experiences, on habitual ways of seeing the world, and the present situation as it looks to us at that moment. Our world, a world that consists of objects with specifiable properties and events, only arises through involved, purposive, and goal-directed activities (Dreyfus 1991). Objects and events acquire their aspects and characteristics, that is, become "real," through our interpretations and articulations. Because articulation of the unspoken is a never-ending process, new interpretations of an object or event are always possible. These interpretations are always from within the individual's horizon that is constituted by past experiences, assumptions implicit in everyday discursive and material practices and the situation. For the interpretations of two individuals to be similar, they have to share a great deal of this horizon (Suchman 1987). The opening episode provides an example that the "objective" feedback information meant something different to students, designers, and competent teachers. Objects also emerge when the inconspicuous, unobtrusive and inoffensive nature of our everyday world and its transparency disappear. As soon as my key strokes do not give rise to the text I intended, the transparent tools are no longer transparent and draw attention to themselves. I begin to inspect the keyboard and become aware of its individual keys or if there is some other problem. Normally, I am not aware of those aspects and do not need to be. And, the aspects of which I do become aware do not have to be the same every time some problem arises, and they are inherently innumerable.

The things of our world are not what they seem to be; that is, the ontological status of things is not given a priori. The ontological status arises from naming and using things in concernful activity. We constitute the ontological character of things and their aspects by using things *in-order-to* do something. In the process of naming and interpreting, language constitutes some things and aspects; it makes manifest that about which it talks and thereby gains its significance against an unspoken but nevertheless ever present background (Heidegger 1977). The discovery of something *as* something, the emergence of structure in that which becomes visible, is a contingent achievement because naming and interpreting are functions of an individual's previous experience and goals as contingently attended.

To summarize, some of the basic assumptions underlying phenomenological thought that influence new approaches to cognition, the design of interactive learning and work environments, and ethnomethodological analyses of everyday practices are these:

- The beliefs and assumptions implicit in everyday practices are not and cannot all be made explicit and are discursively constituted for the purposes at hand.
- Practical understanding, which is observable in the spontaneous activity of people acting in their everyday worlds, is more fundamental than detached theoretical understanding.
- Our primary relationship to the world of our experience is not through having re-presentations of them.
- We are always thrown into a world shot through with meaning which is therefore fundamentally social and cannot be reduced to the meaning-giving activity of individual subjects. Social activity is the foundation of intelligibility and existence, not the individual.
- It makes little sense to speak of things that bear individual properties independently of acts of interpretation. Humans experience the world differently and therefore act in different and changing worlds. To understand someone's actions, we need to understand his/her world.
- Tools obtain two basic modes in their relation to agents: they are ready-to-hand, in which case they are employed transparently to get things done, or they are present-at-hand in which case they draw attention to themselves so that the agent no longer pursues the real goal.

3. IMPLICATIONS FOR LEARNING

Phenomenologically-oriented studies focus on student cognition during activities involving computer-based modeling software and science laboratory activities (Roth McRobbie Lucas and Boutonné 1997, Roth Woszczyna and Smith 1996). These studies confirm the outlined framework:

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- Using the same materials, and without further teacher intervention, students observe different phenomena and develop different language to describe their observations and theories. These observations are more often different from than similar to those of canonical science. Students do not see, hear, and experience a world that scientists and teachers take for granted.
- Many tools which students are required to use in ILEs are, because of inexperience and lack of familiarity, unready-to-hand. Therefore, when students are required to conduct some activity, they frequently learn how to follow instructions, and how to operate a tool in one situation; they learn little subject matter.
- Common understandings and shared practices—using tools, seeing phenomena, describing observations—only arise from intensive interaction over longer periods of time. Canonical understandings and practices most frequently also require interactions with a person already competent in the material and discursive practices to be appropriated by students.
- The world of experience is structured in the process of pursuing relevant activity. Students constitute the ontological character of things and their aspects by using things *in-order-to* do something. When students experience continuous failure—low grades—because they do not discover the teachers' world, they will refuse to commit to learning, always waiting to find out just what the teacher wants.

Phenomenology encourages us to think about cognition in a new way: Cognition is co-extensive with *participation* in lifeforms. One learns the language of science, mathematics, and history as one learns how to play a game: By watching how others play, and by participating in, the game. The language and tools students currently have available shape their practices and limit how they interpret the world, how they act in it, and what they afford them to learn. Language and tools constitute *horizons* for our interpretive and practical actions. True learning is an uprooting process in which students fundamentally change the way they experience the world.

4. IMPLICATIONS FOR DESIGN

The phenomenological perspective outlined so far has important implications to the design of educational materials. Interactive learning environments will fail to make significant impact on learning if they do not account for the learning issues highlighted in the previous section and if they are based on the following assumptions:

- Words and sentences provide unambiguous information and instruction. ILE content and instructions are matters of information and "hard" facts. Information and facts are unequivocal and semantically independent of context and the interpretive frameworks in communities. All users read the same information in the same way.
- ILE can be made clearer and more efficient by providing more and better instructions which can overcome the misinterpretations of users.
- ILE can be self-sufficient so that students can learn individually and without interacting with peers or teacher.
- The fault in breakdowns related to ILE are the users who are computer illiterate, ill-motivated, and uninterested.
- ILE tools can be designed in such a way that they are "idiot-proof."
- Learners need to change their habits and adapt to the requirements of ILEs so that designers can maximize technological advances; technology should drive the development of learning systems and interfaces rather than users current practices.

Traditional design of human-computer interfaces and hypermedia frequently fail because there is a gulf between the ways users and designers look at the world (Suchman 1987; Winograd, 1995). What users see and read, how this shapes their future moves cannot be predicted. This was clear from the data I presented in as introduction where students made situated inferences about feedback that led them into a blind alley. What are the alternatives for designers who do not want to fall into the same old pitfalls? New breeds of designers have drawn different but not mutually exclusive implications based on the outlined phenomenological perspective on cognition. Three approaches have so far yielded improvements in the design processes of ILE and human-computer interfaces. These are ontological, usability, and participatory design.

4.1. Ontological Design

Human-computer interfaces and multimedia can be designed for breakdown. That is, ILEs and their human-computer interface have to make provisions that allow users to overcome communicative troubles between each other and with the media. An important consideration is provision for breakdown (of machines and understanding). All attempts to design for the elimination of trouble are doomed to failure: The unexpected always happens because tools and instructions are inherently flexible to interpretation (Brown and Newman 1985, Suchman 1987). It will therefore not be possible to design away all exigencies and misunderstandings. Ontological design focuses on the management of trouble, communicative and operative, and on the anticipation of breakdown.

What ILE designers must include, then, is a network of auxiliary conversations about system availability, support, training, modification, and so on (Winograd and Flores 1987); that is, ILE designers must not only produce new equipment but also encourage new languages that allow interactions to realize their potential.

The designers of the microworld presented in the introduction certainly did not design for the breakdown in understanding the feedback. The feedback was understandable to the designers and others who have experience in modeling processes. Furthermore, the learning trajectories for the students in the episode and for their peers were far too long to make the computer package feasible for student-centered instruction, unless the curricular requirements in terms of subject matter are decreased. This leads us to issue of usability and designing tools that are rapidly ready-to-hand.

4.2. Usability Design

Another important consideration must be to design ready-to-hand or transparent tools that permit users to get their jobs done without drawing attention to themselves. The success of the Macintosh user interface has been attributed to the fact that it was easily accommodated within users' current practices (among others their language) and therefore was rapidly ready-to-hand (Brown and Duguid 1992). Office personnel did not have to learn a new practice for getting rid of a file, such as "DEL path:/file" but instead put a file into a garbage can, a practice they were already used to. Usability designers explicitly take Heidegger's phenomenological approach to tools and consult on product design within the user community to see what makes them usable, that is, ready-to-hand (Whiteside Bennett and Holtzblatt 1989).

Tools are cultural artifacts that can only be understood in the context of the community that uses them. A well-designed and well-used tool therefore embodies the perspective of the community. Thus, an ILE product that aspires to teach chemistry should allow students to engage in the practices of chemists. At the same time, tools need to be capable of becoming ready-to-hand so that outsiders, who have different perspectives on the tool, can, along a rapid trajectory, appropriate the tool so that it becomes transparent to their practice. An important question then is, Does the ILE allow users to engage in the practices that are characteristic for the domain? (Winograd 1995). One of my preservice teachers recently presented a product that asks students to shoot chemical symbols from the sky. Such an ILE hardly introduces students to the practices of chemists.

The microworld in my introduction, although it was present-at-hand for the students, was a transparent tool for the teacher. This provided two advantages. First, students could learn from the teacher how the interface is used, which aspects and phenomena are relevant to canonical physics, and which descriptions are appropriate. But the teacher's talk made only sense to students after they had some experience with the microworld. Thus, through repeated interactions with the teacher, the students' practices eventually converged with those of canonical physics. Second, it allowed teacher and students to engage each other in conversations about dynamic situations at their hand. Through these conversations, students appropriated and gained experience in canonical ways of seeing and talking about the events in the microworld. Because of the teacher's facility with the tool, he could set up critical experiences appropriate for each group that helped students in learning physics.

4.3. Participatory Design

Troubles can be mediated in part if designers and future users spent a lot of time together to develop common ground, that is, common ways of seeing and talking about the things which computer environment is to accomplish. In this way, designers and users develop shared ways, tacit assumptions and common sense that assists in repairing troubles in human-machine interactions. The conception of knowing as competent participation in language and life forms has led a group of Scandinavian designers to the "participatory design" of computer-based work places (Ehn 1992). The design of intelligible computer-based workplaces requires both designers and users to speak a common language, to participate in a common form of life. That is, before Scandinavian designers could create new work places, they had to create opportunities to develop, with the future users, a common language suitable to communicate their respective interests. They achieved this by using focal artifacts that constituted sites for engaging in conversations with users. They produced mockups, prototypes, and scenarios that were modified as the common ground between participants increased. Together, designers and end users produced and participated in a new language game. Users and designers did not need to understand each other fully when they participated in design-by-doing: participation in a shared design discourse and the use of design artifacts makes constructive but different sense to users and designers (Ehn 1992). In the end, designers and users had created a set of new tools (and associated practices) that were immediately transparent in the users' world.

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5. CONCLUSIONS

At present, the development of interactive learning environments is still very much driven by the worldviews of designers and their common sense understandings of knowing and learning. All too often, ILE designs are imposed on the learner rather than being designed thoroughly from learners' perspectives. The majority of products for the educational market are built on assumptions about learning that are incompatible with research on cognition. As a result these products only continue to store meaningless bits and bytes, encourage rote learning, require considerable time to be used in a transparent and ready-to-hand way. What we need is a new brand of ILE design that takes account of the way humans experience the world. What we need are products that afford the possibility for constructing coherent and recurrent conversations. Because it is often difficult to make sure that all participants talk about the same thing as they converse about conceptual issues in real time, the material presence of the object of talk through the interface must provide students with a means for coordinating just what they are talking about. The immediacy of the display must allow situated references to specific objects and the animation must afford a replay of motion by means of gestures. Through this immediacy, the interface must becomes an object of conversation immediately available. As tools, interfaces need to be designed so that they become ready-to-hand in the shortest time possible. Interface design needs to be driven by considerations of learners' current practices rather than by technological gimmicks. The core message of this paper therefore is: designers risk alienating their target community when they ignore it and when they do not make the effort of engaging with future users and conduct thorough research to find out about their perspectives and implicit understanding it.

Acknowledgements

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The NICE project: Narrative, Immersive, Constructionist/ Collaborative Environments for Learning in Virtual Reality

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Abstract: This paper describes and discusses the NICE project, an immersive learning environment for children implemented in the CAVE and related multi-user virtual reality (VR) technologies. The NICE project provides an engaging setting where children construct and cultivate simple virtual ecosystems, collaborate via networks with other remotely-located children, and create stories from their interactions in the real and virtual world.

The NICE project is an effort to build Narrative-based, Immersive, Constructionist/Collaborative Environments for children. Developed at the Interactive Computing Environments Laboratory (ICE) and the Electronic Visualization Laboratory (EVL) of the University of Illinois at Chicago, NICE aims to create a virtual learning environment that is based on current educational theories of contructionism, narrative, and collaboration, while fostering creativity within a motivating and engaging context.

NICE is an outgrowth of two previously designed systems, CALVIN and the Graphical StoryWriter. CALVIN (Collaborative Architectural Layout Via Immersive Navigation) is a networked collaborative environment for designing architectural spaces [Leigh and Johnson, 1996]. The Graphical Storywriter [Steiner and Moher, 1994] is a shared workspace, where young children can develop and create structurally complete stories. Extracting and building on elements from these previous works, we have created a prototype learning environment for young children which presents simplified ecological models of various ecosystems within a fantasy setting.

The software is primarily designed to run in the CAVE, a multi-person, room-sized virtual reality system developed at EVL. It is, however, capable of supporting a number of different VR platforms, including simpler graphics workstations. The CAVE is a 10 x 10 x 10 ft. room constructed of three translucent walls [Cruz-Neira et al., 1993]. High resolution stereoscopic images are rear-projected onto the walls and the floor and viewed with light-weight LCD stereo glasses to mediate the stereoscopic imagery. Attached to the glasses is a location sensor. As the viewer moves within the confines of the CAVE, the correct perspective and stereo projection of the environment are updated and the user may walk around or through virtual objects. The CAVE's room-sized structure allows for multiple users to move around freely, both physically and virtually. The user interacts with the environment using "the wand", a simple tracked input device containing a joystick and 3 buttons. It is used to navigate around the virtual world, and to manipulate virtual objects within that world.

In the following sections we will explore the various aspects of our approach. Let us first describe an example of a typical session in NICE.

Description of a NICE Experience

Amy and a group of other 8-year olds wear stereoglasses and enter a CAVE. The children are represented in the virtual space by an avatar, a three-dimensional model of a character, in this case a little girl. While moving around in the space the children meet the talking signpost, one of many "intelligent" guides or "genies", which helps to direct them in the virtual world. Among the interesting spaces to explore is the garden. When they enter the vegetable garden they notice a crop growing there already. Claudio and

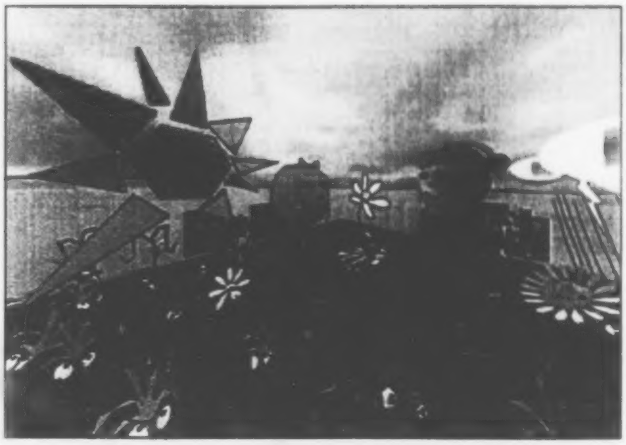

Figure 1: Children, represented by avatars, plant a NICE garden.

his friends, represented by a little boy-avatar, is waving at them. They have been planting vegetables in the same virtual garden from another, remotely-located, computer [Fig.1].

When the kids pick a seed from one of the crates and drop it on the ground, the corresponding plant, flower or tree begins to grow. The children must make sure that their plants are not too close together, and that they get enough water and sunlight. They can water the vegetables by pulling the rain cloud over them and provide sunlight by pulling over the smiling sun genie. When a plant is adequately watered, it pops up an umbrella and the children pull the cloud away; when the sunlight is too bright, the plant wears sunglasses; when it feels crowded it starts moving restlessly. The two groups of children work together to keep their garden clean and healthy. They exchange seeds and flowers, they clear out the weeds by recycling them in the compost heap, and they gather the successfully harvested vegetables in a barrel. The heavy barrel can only be lifted with the help of all remote participants and carried away from the garden. Sofia, the friendly owl genie, provides constant assistance, and the birds help with the planting.

This simple ecosystem will continue to evolve and the kids can come back and check on their progress at a later time. More children can choose characters to represent themselves, and join in from remote computers. Teachers or parents can participate, either as members of the groups, or disguised as genies. This allows teachers to advise the children in person or to direct parts of the activity from "behind the scenes". They can also predetermine the pace at which the world evolves; they may choose to see the plants grow very quickly, or, in the case of a school project, extend their growth over the period of a semester. Upon leaving the virtual environment, the children can obtain an illustrated version of their experiences in the garden they have created.

Combining Constructionism, Narrative, and Collaboration

NICE focuses on bringing together concepts of constructive group activity and narrative, within the nexus of motivation and exploration. A theoretical framework which combines the ideas of constructionism, narrative, and collaboration provides the underpinning for this environment. In the following sections we will describe the technical aspects as well as the underlying pedagogical principles of the system.

Constructionism and Exploration

Constructivism is an approach to learning that has received much attention in the educational technology circles and is being applied to many current educational software projects. Based on the learning theories of Dewey [Dewey, 1966], Piaget [Piaget, 1973], and others, constructivism deals with the ways learners assimilate knowledge by engaging in self-directed learning activities which are accomplished

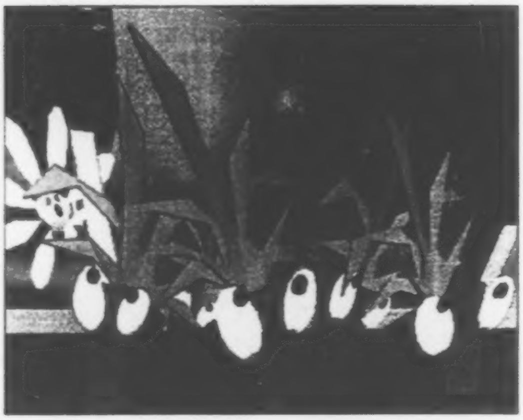

Figure 2: Becoming small in the carrot garden.

through constructive tasks. Exploration and the process of constructing objects are viewed as integral parts of these learning activities. We too believe that learning is situated in the activity of making [Brown et al., 1989], manipulating, and exploring objects, systems, and ideas. In NICE, constructive play is made possible with virtual building blocks that contain characteristics physical toys or learning tools do not: the kids can pick up heavy or large objects, hand them to other remotely located children, combine them to build new objects, or instantly observe their changing attributes over time. They can determine the environment characteristics, change their own body size [Fig. 2], disappear, fly, or leap high in the air.

All the objects, avatars and genies in the world are VRML models, which can be moved and scaled by the child in real time. The plants, trees, and flowers are simple agents with common rules of evolution and behaviour which are based on simplified ecological models. They contain a common set of characteristics that contribute to their growth, such as their age, the amount of water and sunlight they need, and their proximity to other plants. The combination of these attributes determines the health of each plant and its size. As soon as Amy drops the carrot seed on the ground, the carrot will start to grow. When she pulls the cloud over to water it, the carrot will grow faster. Visual and audio cues aid the children in determining the state of each plant or flower. The carrot will pop up a small animated umbrella to let Amy know that it doesn't require any more water. These models are handled by a central behavioural server called LIFE, which also controls the actions of the genies and story structures. LIFE can be operating constantly on any centrally located computer thus maintaining a persistant virtual world.

Narrative

Papert believes that learning takes place when engaged in the construction of a personally meaningful artifact, such as a piece of art work, a story, or an interactive computerized object [Papert, 1980]. One of the products of constructive activity in the NICE environment is the narrative, the stories formed and created by the kids that participate. The narrative revolves around the construction of the ecological microworlds and the reactions or decisions taken while interacting with the genies. Every action in the environment adds to the story that is being formed continuously, even when there is no interaction by the kids. Each child may choose to join or leave the story set at any time, while the world continues to evolve through time; the plants grow, the animals populate newly formed ecosystems or migrate to other areas, the weeds take over neglected gardens, and the flowers wilt when not watered. The narrative structure captures all of these actions in the form of simple sentences such as: "Amy pulls a cloud over her carrot patch and waters it. The tomatoes complain that they didn't get enough water. Claudio plants his first tree".

This story sequence goes through a simple parser, which replaces some of the words with their iconic representations and publishes it on a WWW page. This gives the story a picturebook look which the

Figure 3: A NICE story on the WWW.

child can print to take home [Fig. 3]. Most of the time these stories do not accomplish narrative closure, rather they come across as a series of interactions between the characters and the world. Nevertheless, the children enjoy this process, especially when they get to take home the written and illustrated version of the narrative in either printed or electronic form, or an electronic version of the scene, generated as a virtual model. The two-dimensional version of NICE also allows the children to interact with the three-dimensional VR space and create their stories through the use of Java applets on the Internet.

Collaboration

Equally important to the construction of one's knowledge is the experience gained by participation in group activity. Collaboration is emphasized in our framework through the combination of collaborative learning across both virtual, as well as physical communities. Collaboration of virtual communities refers to communication and shared experience between children who are geographically separated. The network component of NICE allows multiple networked participants at different locations to interact with each other and share the same virtual space. The representation of each tracked child in the virtual space is established through the use of an avatar with a separate head, body, and hand. As each person's head and hand are tracked, this allows the environment to transmit gestures between the participants such as the nodding of the user's head, or the waving of the user's hand to the other participants. Visually, the wand is mapped to the arm of the child's avatar. As the child waves her hand in the real world, her avatar waves its hand in the virtual world. As these avatars have sufficiently detailed representations, the children can communicate notions of relative position to one another with phrases such as "it is behind you" or "turn to your left." The use of audio (with wireless microphones) between the various sites enhances the communication process.

The number of participants is limited only by bandwidth and latency of the network. Multiple distributed NICE applications running on separate VR systems are connected via the central LIFE server to guarantee consistency across all the separate environments. The communications library uses multicasting to broadcast positional and orientation information about each child's avatar, and uses TCP/IP to broadcast state information between the participants and the behaviour system.

Collaboration in NICE may also include the interaction between the kids and the computer genies, which populate the virtual environment. The genies operate as interface and feedback mechanisms, disguised as helpful character guides that interact in the virtual world. They provide a way to replace menus and other traditional interface techniques with a more transparent and effective method for use by young children. Many times, when developing and testing the system, we use the Wizard-of-Oz prototyping technique [Wilson and Rosenberg, 1988], where actual people, disguised as genies, simulate agent behaviour. The children may be unaware of which characters in the environment are controlled by the computer and which by a human operator.

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Collaboration also involves the social interaction among children located in the same physical space. Theories that emphasize the importance of social interaction in cognitive growth [Vygotsky, 1978] suggest that successful collaborative learning involves more than the final creation of a learning product. Learning that is contextualized in a social setting may involve verbal interaction, collective decision making, conflict resolutions, peer teaching, and other group learning situations characteristic of a classroom setting. With the use of VR technology that supports multiple users in the same physical space, as well as appropriate interaction techniques, a number of kids can participate in the learning activity at the same time, without having to take turns or wear heavy and intrusive hardware devices.

Evaluating the Virtual World

You may ask whether Amy and Claudio really need to enter a virtual environment to learn about ecology or social interaction. Wouldn't it be better if they planted a natural garden as part of a real outdoor classroom activity? Issues on the viability of VR versus traditional teaching methods are of concern to the educational world, which likes to take into account both pedagogical and practical issues.

While there are no substitutes to planting a natural garden or interacting with other children in the playground or at school, a VR environment can provide rewarding learning experiences that are difficult to obtain otherwise. As an example, ecological systems are usually complex models with many variables and behaviours that young children have difficulty visualizing. Computers can be effective at reducing the complex models into simpler qualitative representations. VR adds the qualities of immersion, direct manipulation, and exploration of such models. While in a real garden children can learn how to plant, in the virtual garden they can learn how to think about plants, scale and position parts of an ecosystem, take on different roles, become small to observe the roots, talk and interact with children at distant locations, or factor time to directly observe the effects of their changes.

However, in order to justify the educational value of the technology, effective evaluation methods need to be established to discover if conceptual learning takes place. Yet, very little has been carried out in the direction of evaluating VR environments for their educational effectiveness. In the past few months, we've observed small groups of children, 6-12 years of age, using the system, while in its various development phases. [Fig. 4]. We are particularly interested in studying the effects of VR as a learning tool, by conducting research on interface, orientation, immersion and presence, affective, cognitive, and conceptual learning issues. We have developed an evaluation framework, which takes into account the measurement of both usability as well as conceptual learning attributes of the virtual environment. With this framework we try to see through the fascination and novelty effect that surrounds this new technology and explore the actual learning experiences it has to offer. A variety of techniques are employed for gathering data, both embedded in the computer and external. The evaluation process includes the creation of a real garden by children participating in school and community-based projects, in combination with the collaborative construction of the virtual ecosystems [Roussos et al., 1996].

Although the cost and size of the CAVE, or even smaller VR technologies prohibits their use in today's classroom, it will not be long before the networked and technology-rich classroom becomes a reality. As the technology continuously decreases in cost and increases in power, more museums and cultural centers are beginning to acquire multi-user VR systems which allow for many children to participate in the experience at once.

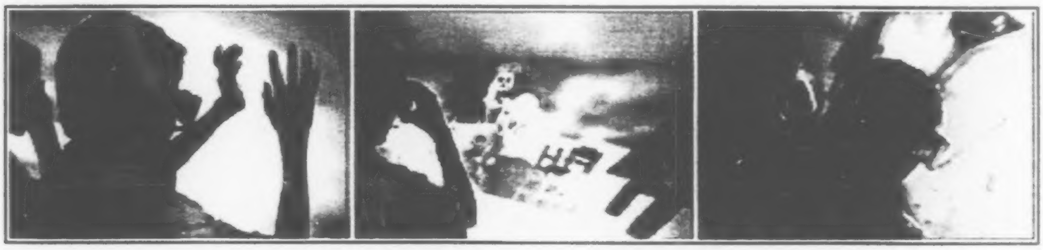

Figure 4: Children interacting with the NICE world.

Future Directions

A current goal for NICE is to further refine the interface by developing techniques for more natural modes of interaction that improve the direct manipulation of the environment and don't interfere with the learning process. Replacing the wand with a data-glove or physical gardening tools is one way of approaching the hardware interface problem. The use of many small and simple artificial guides is another improvement of the interface in the software. "Intelligent" characters can offer a clever alternative to a menu and provide direction to the children while hiding the computer.

An important addition to the present configuration is an authoring tool which will allow for user programmability of the ecosystems. This authoring tool will be in the form of a simple visual language. Visual languages have been shown to be ideal programming languages for children because they can map abstract concepts to pictorial elements that they are more familiar with [Soloway et al., 1996]. We envision a visual language where a system, as complicated as NICE, may be programmed by manipulating iconic representations of data and operators, provide immediate feedback, and can be learned quickly by the kids. Our current direction is a two-dimensional interface where the child, by clicking and draging icons to control the ecological models, can observe immediate feedback and effect in the three-dimensional VR environment.

Finally, in the direction of collaborative learning we are investigating issues of self representation and non-verbal communication. The children greatly enjoy seeing other avatars in the virtual space. One of their favorite activities is to exchange flowers and thank each other by waving, moving their heads up and down, or bowing. They also like to visualize the presence of their body in the reflecting pools in the VR world. These directions provide potential for interesting studies in gesture communication and theatrical improvisation.

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Mathematical Giftedness and Development of Mathematical Word Problem-Solving Skills in a Technology-Based Learning Environment: a Teaching Experiment

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Abstract. This article examines a teaching experiment in mathematics realized for fifteen years old students at Kaukajärvi School in the city of Tampere, Finland. The teaching experiment is a part of a study dealing with mathematical giftedness and development of mathematical word problem-solving skills in technology-based learning environment. In the study an empirical group comparison method was used. During the teaching experiment the group A studied problem-solving in the technology-based learning environment using SOLVER - developed for this purpose - application as a tool for learning. In producing the learning materials a contextual perspective on learning was adopted. Constructivistic, collaborative and situational views of learning were taken into account in the learning of group A. The group B studied the material with the traditional teaching methods, using paper and pencil only. A control group did not take part in the teaching experiment.

1 Introduction

The aim of this study is to examine the connection between a technology-based learning environment with the development of problem-solving skills of students at different levels of mathematical giftedness. In this study we compare the development of problem-solving skills achieved in a technology-based learning environment with learning environment of traditional paper and pencil tasks. During the teaching experiment of this study we collected data on SOLVER's suitability to develop students problem-solving skills on different levels of mathematical giftedness. [On SOLVER see Ruokamo-Saari 1996a, 1996b, 1996c.]

This study forms an independent part of the Schools to Information Superhighway (SISU) Project [see Koskelainen et al. 1996a, 1996b]. A group of mathematics teachers at Kaukajärvi School prepared problems and their model solutions for SOLVER application in cooperation with the researcher. SOLVER was produced as a part of the Näsnetti Project of Multimedia Services of Alexpress Ltd. of Aamulehti Group Ltd. The Näsnetti Network Multimedia Project belongs to The Finnish Multimedia Programme (FMP) (*http://www-tre.research.nokia.com/*). Nowadays this study is a part of Distance Learning in Multimedia-Networks project (*http://matwww.ee.tut.fi/kamu/*) of the Finnish Multimedia Programme (FMP).

This article describes the teaching experiment that was realized in the learning environment developed at the Kaukajärvi School in spring 1996. Students taking part in this study were ninth grade students. The contents of SOLVER were designed taking into account a contextual approach: word problems are connected to real life situations and thus to the real world. The solving of the problems is done collaboratively and the view of learning is "moderate" constructivistic. [cf. Ruokamo-Saari 1996a, b and c.] The theoretical background and research questions of this study has been reported earlier [see Ruokamo-Saari 1995].

2 The Methodological Solutions

The main aim of this study is to examine the connection between a technology-based learning environment and the development of problem-solving skills. In this study we compared differences in the problem-solving skills of students on different levels of mathematical giftedness - when they have been studying in different learning environments: in a technology-based learning environment and in a learning environment of traditional paper and pencil tasks. This study is experimental. The experimental group A studied in the technology-based learning environment and the experimental group B studied in the traditional way. The control group did not study problem-solving. The SOLVER application is a part of technology-based learning environment developed for this purpose. The suitability of this learning environment in the development of problem-solving skills and for the learning of mathematically gifted students was tested via the teaching experiment.

2.1 Experimental Design and the Participants of the Study

The research is an empirical and experimental comparison study of randomly chosen student groups. Experimental groups were made by lottery. The experimental design of this study is presented in Figure 1. below:

Experiment group A - MR ------ M1/A1 ------ TBLE/S1 ----- M2 /A2 ----- MM/MT ----- M3

Experiment group B MR ----- M1/A1 ---------- PP ---------- M2/A2 ----- MM/MT ----- M3

Control group MR ------ M1/A1 -------------------------M2 --------- MM/MT ----- M3

Figure 1. Experimental design of the study

In the experimental design MR (for all the groups) refers to the matrices test of Raven, M1 refers to the pretest of problem-solving skills and M2 to the posttest. A1 and A2 are tests of attitude towards mathematics, word problem-solving, computers (A1) and towards the environment used in the teaching experiment (A2). MM is a test that measures essential mathematical knowledge [Kupari 1983] and MT measures text comprehension [Linnakylä 1989]. TBLE and PP are environments - TBLE is technology-based learning environment and PP is traditional environment of paper and pencil tasks which influence the problem-solving skills we are trying to assess. [cf. Cohen and Manion 1987.] S1 for students in a technology-based learning environment denotes inquiry associated to SOLVER. M3 (for all the groups) means delayed test of lasting quality of problem-solving skills. The control group took part into the pre-, post- and delayed tests and measurements of mathematical giftedness. The purpose of these tests was to find out the differences between the students who have practiced and who have not practiced problem-solving and to find out the possible influence of pretest on posttest.

We were aware of possible consequences for students' and teachers' work when in designing of the experiment we decided to change existing grouping. Existing groups were divided so that we got three as homogenous groups as possible. Students were selected randomly. The division into the groups was made randomly so that each group consisted of 11 girls and 11 boys. In the beginning we wanted to have two times twelve students in each group, but because one computer was broken during the whole experiment, we had to make the groups smaller by taking one girl and one boy out of the groups by lot. We decided to select students randomly, this would probably not cause marked difference with matching.

Students of the technology-based learning environment group were grouped into working pairs on the basis of gender and of success in the pretest as shown in Figure 2. below:

Gi	Gi		Be	Be	
Gi	Be		Ge	Ge	(video recording 2)
Gi	Ge		Bi	Bi	
Ge	Gi		Bi	Be	
Ge	Bi	(video recording 1)	Be	Bi	
Ge	Be				

Figure 2. Student pairs made according to gender and success in pretest

Capital letters indicate the gender of the student: G for girl and B for boy. The low case letter indicates success in the pretest: letter i stands for inferior success and letter e for excellent success. We were also able to record on video all student pairs and simultaneous screens from two pairs of students while they were working.

2.2 Teaching Experiment

The teaching experiment and collecting the data lasted *11 hours*. It started at the end of the autumn term 1995 and it lasted to the end of the spring term 1996. Because in the schedule of Kaukajärvi School there was no mathematics for ninth grade students during the period January-March, we arranged six teaching lessons beginning on Friday 22nd of March 1996. A pretest was arranged before the lessons on Monday 18th of March. We collected data during the period on Friday 22nd to Friday 29th of March on consecutive math lessons, simultaneously with different groups. The first test, Standard Progressive Matrices (SPM) of Raven, was arranged on the 10th of October 1995 and last test, the delayed test, was arranged on the 15th of May 1996. The whole teaching experiment progressed stage by stage as follows:

- In the first lesson (10th of October 1995) we measured the reasoning ability of all (N=98) the ninth grade students from Kaukajärvi School with the SPM of Raven. The test lasted one hour. The test of Raven was the first part of the evaluation of students' mathematical giftedness.
- In the second lesson we arranged a pretest of students' problem-solving skills. The test lasted 45 minutes. After that we also arranged an attitude test that lasted 15 minutes. With that test we evaluated students' motivation and their attitudes towards mathematics and towards mathematical word problems and towards computers.
- The students were grouped randomly into an experiment group A (N=22) and an experiment group B (N=22) and a control group (N=22). All 66 students took part in the teaching. During the six consecutive mathematics lessons (on the 22nd, 27th and 29th) at the end of March, we collected data from student's problem-solving processes and skills and their thinking while they solved the problems. Experiment group A worked in pairs during lessons collaboratively with other student pairs.
- The posttest of students' problem-solving skills (lasting 45 minutes) was arranged after the teaching lessons (on the 3rd of April), when we also measured the attitudes of students of the experiment groups. The attitude test, lasting 15 minutes, measured students' attitudes towards learning environments and also to the experiment. On the basis of the post test we evaluated possible differences between the development of problem-solving skills of the students from the experiment and the control groups compared with pretest.
- After the posttest (on the 4th of April) we arranged two tests of mathematical giftedness; a test of mastery of core mathematics (15 minutes) and a test of text comprehension (30 minutes).
- One and a half months after the teaching lessons, on the 5th of May, we arranged the last test of the experiment, the delayed test (45 minutes). With that we tried to ascertain the stability of problem-solving skills in students, who had studied in different learning environments.

In a next chapter we describe the data collection in a more detailed way.

2.3 Measurements and the Data Collection

We collected data on mathematical giftedness with three different kinds of tests: SPM of J.C. Raven [1958] to evaluate reasoning ability, a test made of tasks of mastery of core mathematics by a P. Kupari [1983]. With this test we tried to evaluate the students' mathematical knowledge. The third test was by P. Linnakylä [1989]. With this test we tried to evaluate how ninth-grade students learn from the text. We made pre, post and delayed tests of mathematical word problem-solving to collect data of students problem-solving skills. We also made attitude and motivation tests in regard to mathematics, word-problem-solving, computers, teaching experiment and learning environment. We also collected data by recording mathematics lessons on video both in a traditional paper and pencil environment and in a technology-based learning environment. From the video material we examined the students learning processes and their interaction during the lessons. We also interviewed two student pairs, who studied in the technology-based learning environment, after the lessons using the stimulated recall-method (STRI) [Bloom 1953]. All the interviews were recorded on c-cassettes. We had recorded simultaneous screens on video from those two student pairs who studied in a technology-based learning environment, with those tapes we connected pictures from working student pairs and their computer screens. The researcher and a research assistant observed these student pairs working in real-time from TV-monitors in the class and made observations of problem-situations. The interviews were made on the basis of recorded videos and problem-situations that had been noticed during problem-solving. The interviews were carried out as soon as possible after the lessons. SOLVER saved log-files and made saving and backup files from the working of all the student pairs and their solution trees. Discussions of the student pairs via bulletin board were also saved on a server. We analyzed students' problem-solving and thinking processes and their development on the basis of these tapes, cassettes and saved files. We will also examine the effects of student pairs discussions and discussions between the students and the teacher, too - in special, how these discussions affect the problem-solving process. What kind of problem-solving processes do those girls have who did well in the pretest? What about the successful girl and the not so well successful boy? How students think about their own thinking processes has an essential role.

2.4 Analyzing Methods

In this study we analyze data using both quantitative and qualitative methods. The data comprises the scores of the tests of mathematical giftedness and the scores of the pre, post and delayed test and the scores of the motivation and attitude tests of the experiment and control groups.

The reliability of the statistical methods is dependent of the number of the cases - all in all 66 students participated in the lessons of the teaching experiment. We are, for example, able to make descriptions on the basis of frequencies and we are able to examine the connections between the variables by using correlation and crosstabulation.

We are not able to show an individual's higher or complex abilities by using only quantitative research methods [c.f. Krutetskii 1976]. We will analyze student's problem-solving processes also using qualitative techniques by observing them in different learning environments during the teaching experiment and by analyzing students' working on the basis of video tapes and cassettes that were recorded both during and after the lessons. The interviews (STRI-method) of the two student pairs after the lessons and discussions of their feelings and thinking processes, their functions and selections form the bases of the qualitative data. We are also able to analyze qualitative data from all the files saved by SOLVER and from video tapes and their simultaneous screens.

3 In Conclusion

What kind of connection there is between the learning environment and the development of problem-solving processes among students with different levels of mathematical giftedness? Unfortunately we are not able to answer this question yet. This research is at the stage of analyzing the data, which is why we are not able to give final results. It is always problematic to use experimental design: there might be some other factors in the learning environment which affect the development of the problem-solving processes that we are not immediately aware of. We have to find out the effect of these factors when analyzing the results.

This experiment was the first teaching experiment using ATM-network constructed in the Schools to Information Superhighway (SISU) Project. We had quite a lot to do with technical questions before we were able to start the experiment. Special thanks are due to the Alexpress Ltd. of Aamulehti Group Ltd. for SOLVER's technical implementation and programming and to the Digital Media Institute of Tampere University of Technology for technical support and organizing. We gratefully acknowledge the students and the teachers of the Kaukajärvi School, who were so willing to collaborate and had positive attitudes towards the experiment.

The aim of the analysis in this research is to connect qualitative and quantitative data so that they form a complementary and integrated whole. We will use the method of triangulation when analyzing the results. We have collected a large amount of data in many different forms - the analysis will still take plenty of time.

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An Authoring Paradigm with Parametrization and Project Design Support

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Abstract

There is a large number of authoring tools on the market for authors to chose from. Such systems usually adopt different approaches to authoring with ranging complexities. Much of the research today has focussed on how would the final multimedia application look. On the one hand, we see that such research has resulted in the development of many multimedia authoring models, databases and tools. On the other hand, there is little, or even a lack of, concern with authors and the process of authoring itself. This work looks at the problem of authoring from the authors' point of view. This process is analyzed and some guidelines, in the form of paradigm, are produced describing its main stages and characteristics. A new authoring paradigm, starting with application parametrization and going all the way to fine grained object instantiation, is proposed to overcome some of the identified problems today's authors face up.

1) Introduction

The wide spread use of multimedia tools often involves people from different walks of life including education specialists, designers, publishers, marketing and sales personal and film producers. The integration of various media has proven to be a powerful mean to facilitate communications and persuade users. It is the dynamics of media such as video and audio that makes information absorbing go beyond the mind, carrying new human dimensions such as emotions and feelings. As most multimedia users are not computer literates, we look at how easy it is for them to produce multimedia presentations under current multimedia authoring tools by analyzing the stages, components and complexity of the authoring process itself.

This paper first starts with a description of the authoring problem and its requirements. The underlying authoring model is presented. Next a quick overview of existing authoring paradigms and a comparison of these are made. Then, the proposed new paradigm is discussed. Finally, some conclusions are drawn and plans for future work are presented.

2) Authoring Paradigms - a Quick Review

Authoring refers to the process of creating anything in any area of human knowledge, generally through the help of specialized tools. Authoring should be a systematic and a well structured process. There are very few techniques specifically designed for the authoring of hypermedia documents. A great deal of these are empirical techniques [Garzotto, Paolini and Schwable 1993]. Currently there is no completely "point-and-click" authoring system; some knowledge of algorithm design and heuristic thinking is required [Siglar 1995]. As it is, authoring can be seen as an enhanced mode of programming where although the author neither has to learn a

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programming language nor has to use a specific Application Programming Interface (API), a basic understanding of how programs work is needed.

A number of authoring paradigms can be distinguished depending on the authoring technique used. Usually a combination of one or more of the following paradigms is found.

- *Time and Flow based Iconic Representation :* At the heart of this paradigm is the use of an icon palette and a flow line. Whereas the icon palette defines all possible functions and interactions of a program, the flow line provides the way the icons are linked or arranged. This authoring style is best suited for rapid development but suffers in the way of execution since icons have different execution permutations. Examples of packages using this style of authoring are Authorware and IconAuthor.
- *The Frame Paradigm*: Similarly to the flow based paradigm, it implements a palette and links among icons. These are sometimes conceptual and do not always show the actual execution flow. It therefore offers an abstract level closer to Hypermedia. QUEST for Windows is an example of a frame based authoring package.
- *The Scripting Paradigm*: Provides a closer form to programming in that it supports an interpreted scripting language. Such a language would implement functions for the manipulation, combination and presentation of multimedia elements. These include flow control, hot-spots and links management, synchronization and presentation. Authoring systems based on this paradigm define a strong object oriented scripting language. Although the use of scripts provides support for powerful interactivity with the application environment, it nevertheless, tends to make development more time consuming. Despite the script language being interpreted, rather than compiled, the gain in terms of run-time is rather minimal when compared to other systems using different paradigms [Siglar 1995].
- *The Card Scripting Paradigm*: Combines the use of a card metaphor together with access through a script language in its user interface. This paradigm is well suited for hypertext applications and navigation intensive applications. Its main drawback, however, is the use of low performance index-card structure. Tools that adopt this paradigm include Apple's HyperCard and Toolbook from Asymetrix and Allegiant's SuperCard. HyperCard does not separate between structure definition of the hyper-document and its implementation. It adopts the "Card/Scripting" authoring paradigm. The author starts programming in the Hypertalk language!
- *The Cast Score Scripting Paradigm*: It uses a music score as its primary authoring metaphor where the synchronous elements are shown in various horizontal tracks with simultaneity (synchronization) shown in the vertical columns. Director is a widely used authoring package that follows this paradigm. Applications best suited for this style of authoring include those where animation and media synchronization are both intensive. Usually support for an object oriented language is included [Siglar 1995].
- *The Collection Paradigm*: This style of authoring allows the creation of collections which represent separate views of multimedia objects. These can be structured, in a hierarchical way, in order to support zoom-in and zoom-out operations. HM-CARD is an example of an authoring system based on this paradigm.
- ***Direct Timing Relations***: Defines timing relations to be included directly into objects and removes therefore the concept of a time and flow based line. This has the advantage of making the insertion and removal of objects a simpler task. Examples of authoring systems that implement this paradigm are Harmony [Fujikawa 1991] and the Videobook system [Ogawa and Kanedo 90a] The latter permits the grouping of scene objects into scenes which can be manipulated without having to figure out where in the time line they fit.
- *The Structure Paradigm* : Allows the structure based composition of multimedia presentations. Using this authoring technique, as described in [Rossan, Hardman and Bulterman 93a] , the author constructs a presentation in terms of two things, namely, its structure and additional synchronization constraints. The system proposed in [Rossan, Hardman and Bulterman 93a] defines two main aspects of multimedia presentation: the structure of the presentation from which based timing constraints can be derived, and the assignment of logical resources. Once the structure has been defined, the model is able to derive most of the synchronization information. Similar work has been accomplished in [Buchanan and Zelleweger 92a] . Two support views of a CMIF document are found, a hierarchical view showing the structure and a channel view showing the logical resource usage. The proposed paradigm requires a relatively greater learning curve when compared to some of simpler ones. As far as we know, there has no implementations of systems using this paradigm.

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3) Discussion of Authoring Paradigms

An authoring paradigm determines the way the author undertakes authoring tasks, it therefore becomes an important component of the user interface. Due to the complexity and diversity of authoring information, a number of authoring systems have adopted different paradigms most of which have been already described.
Whereas time and flow based authoring is intuitive and best suited for rapid development, it does not capitalize on the inherent modularity of the presentation. Both time line and script based systems have this drawback and suffer in terms of execution. Fragmentation and difficult reuse of parts of the presentation are also limitations of these paradigms [Rossan, Hardman and Bulterman 93a].
The use of index-card structure makes the card scripting paradigm less attractive because of its low performance. Although the script paradigm offers a strong interactivity with the environment and better flexibility, it presents however a longer learning curve especially for authors with limited or no programming experience. Some of the paradigms are biased towards specific applications. A case in the point is the cast score paradigm which has better handling of interactive presentations and animations where synchronization is of prime importance. [Rossan, Hardman and Bulterman 93a] discusses the limitations of existing authoring paradigms and suggests a new paradigm based on structure authoring. It defines where and when objects are presented on the screen or on audio channels. Structure based authoring is far from being intuitive and requires a greater learning curve than the time and flow based one for example. Furthermore, changes to derived synchronization information is not simple to handle. Whereas card based systems are suitable for small applications, there is the risk that the author may loose track of the piles of cards and their inter-relating within an application with a high number of cards. It is the view of this work, that structure editing is the responsibility of media specific support editors rather than authoring systems. Furthermore, authors' made changes to the structure in either of the hierarchical or channel view are not simple to grasp and may have unexpected results. It is also not easy for the author to associate corresponding objects within both views. Authoring information is not always hierarchical, therefore the adoption of a hierarchical view is very limiting. The discussion above argues that none of the existing paradigms can be considered as best suited to authoring systems.
In order to avoid the limitations above and to provide support for a wide range of applications with different degrees of interaction, animation, learning curve and ease of use, the proposed solution makes use of a combination of the icon, time line, structure based paradigms and direct timing objects. This way authors may tend to use more a given combination of paradigms rather than being limited to a particular way of authoring.

4) The Authoring Model

Before, we describe the adopted paradigm, we look briefly at the ACAM model. A model offers an authoring language and makes development a structured task independent of the application. The Active Context-Based Authoring Model (ACAM) is a distributed multimedia generic authoring model. It defines four main modules for presentation, authoring, hypermedia and distribution support. The full model is described in [Kelner, Sadok and Silva 96a]. The authoring module is the object of study in this paper. It is divided into two main parts: authoring in the large and authoring in the small . Authoring in the large is the process that starts the modeling of an application at the most abstract level possible required by the author. This specification is then continuously refined until it results in one that is as close as possible to the application being presented. The advantages for such a separation include the possibility of re-using the conceptual model in the design of other applications where different refinements/extensions could be made in order to adapt this to its new application target. This is similar to the template concept used in software engineering design.

4.1) ACAM Contexts

The reader of a hypertext/hypermedia system is in charge, taking decisions in order to navigate through the contents of the islands within a hyperdocument sea. The cost of hypermedia style of retrieval is a cognitive overloading which could lead to the user loss of orientation.. This overload is a result of the fact that any piece of information could, potentially, be linked to any another one, from a different topic. There is a risk that the user or author may get lost in the hyper-space. In order to overcome this problem it would be far more appropriate to eliminate its cause, i.e. the within the authoring process in itself, through the use of a tool equipped with both an intuitive and natural information concept, referred to as context authoring .

5) ACAM's Authoring Paradigm

The aim behind the study of exiting paradigms, is to find one that supports the author in thinking in higher terms and where it is the responsibility of the system to translate the authors document into lower layer objects by automatically generating, whenever is possible, the corresponding lower level constructs.

The discussion has shown that different paradigms have different strengths and that there is no single one that outperforms all the others for all considered applications. This discussion is somehow similar to the question of which programming paradigm will dominate the future of software development. A reallistic conclusion which also confirms the current trend in programming languages would be that different paradigms would coexist at least for a while and that each one of these would have its own "niche" of applications. Similarly, in the context of authoring, a system would stand better chances of being accepted, if it successfully combines different authoring paradigms in a such a way that they appear as collaborating to enhance application semantics.

5.1) Requirements

Before presenting our solution, we look at what we hope a paradigm would achieve. In order to make the authors life easier, the retained paradigm should, in our view, observe the following requirements:

- a clear authoring process with well defined stages must be defined. Such stages should not be confined to authoring in the small (i.e direct object instantiation);
- the paradigm must avoid as much as possible the use of complex mechanisms such as scripting languages;
- simplicity intuitiveness and ease of use over power in that the user interface must be made simple by keeping the number of open windows low;
- the retained paradigm must be generic, with support for reuse and extendible;
- problem parametrization is important as the same multimedia presentations may be made available in different forms, levels of details depending on the target audience;
- support for contexts, authoring in the large and authoring in the small described earlier;
- support for media synchronization;

5.2) An Analysis of the Authoring Process

In order to support the above requirements,the ACAM user interface adopts a balanced combination of the following paradigms: time line and flow icon based paradigm, t he collection paradigm.

So far we have discussed the different paradigms and modeling techniques the proposed solution will have. Next, we describe in chronological order, which concrete authoring stages this solution defines in order to implement the proposed new paradigm. To implement the four ACAM's modeling parts, namely, conceptual, navigational, presentation and instantiation, the proposed paradigm defines seven stages that an author may execute sequentially or in a cyclic way. These are:

1. *application parametrization*: defines parameters controlling the application. Examples of these maybe the the levels of users (beginners, advanced,..) , the application purpose (education, entertainment, sales..), users age, presentation language, etc. The idea is that for each set of parameters, the same application using the same underlying model presents a different scenario. Note that this parametrization is represented by the concept of contexts earlier defined in the ACAM model;
2. *Definitions of blocks, sub-blocks and relations*: Here the application is structured in terms of blocks of information and the relations between the blocks are established. When a new block is created, the author says which context it is inserted [Fig. 1.b] in and the system can infer the navigational model. The way a

block is going to interact with another one, through the use of a selection button or after a given time has elapsed, is defined later together with the information that makes up a bloc. A user may select a bloc and define its graphics and synchronization information separately from other blocks, guarantying therefore their reuse and extendibility. They can be saved and opened separately. See [Fig. 1.a].

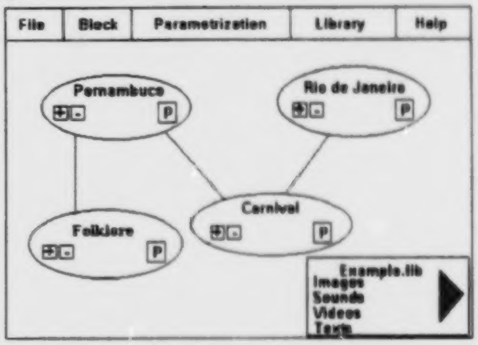
3. *Definition of a media library*: The user may now gather all the objects he will possibly use. These will be kept in a library and this library may be saved and reused. During the development, the author may have more then one library opened. Library objects may be real ones such as (sound, text, image, or video files) or significant names that will be instantiated later on. libraries may be continuously updated and may be stored in a multimedia database for use by other applications. An example of a library creation is shown in [Fig.1.c].

Working per block.
The author may now select one block and start working with it. See [Fig.1.d]

4. *Defining the graphics information of a block*: the author is now provided with an empty window , a graphic tool bar and the library which is always accessible. The author will build frames defining the locations of objects (except the sounds), constructing the screen structure of this block. Then he drags the desired blocks from the library and these objects will fit the pre-defined frames. As the objects are chosen the system relates them to the currently active block, and they are grouped at the bottom of this phase's window. [Fig. 1.e] shows this process.
5. *Definition of the flow and object synchronization of a block*: using this option the author may define temporal relationships among the objects of a block, through the use of a flow line to which a time scale has been incorporated, in order for these relations to be as much visible as possible. The icon "*link*" indicates that there is an interaction (as a button or a clickable object, etc.) that will deviate the flow of the presentation (represented by the left line in [Fig. 1.f] to the line below itself (the right line in the example). The deviation caused by the interaction may be from one block to another (using the icon "*block*" or among elements of the same block. It is also provided the "*rubber*" icon to control the disappearing (with or without special effects) of objects or blocks. The "*function*" icon is used for pre-stabilished functions like exit, go to another block without interaction. The elements are placed on the flow/time line according to their temporal relations and they can be stretched to visually represent their durations.
6. Test: the author may, during the authoring process test or run the entire application, or use selective testing of blocs. Any of the steps above may be repeated by the author at any time to introduce new changes.

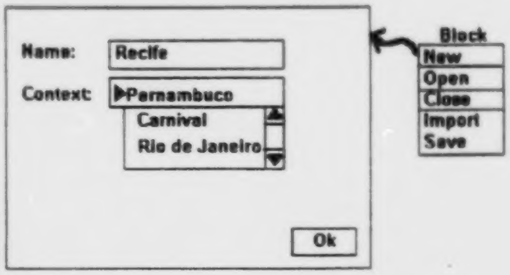
Any of the steps above may be repeated by the author at any time to
introduce new changes;

a)



c)

b)



Name: Recife

Context: ▶Pernambuco

d)

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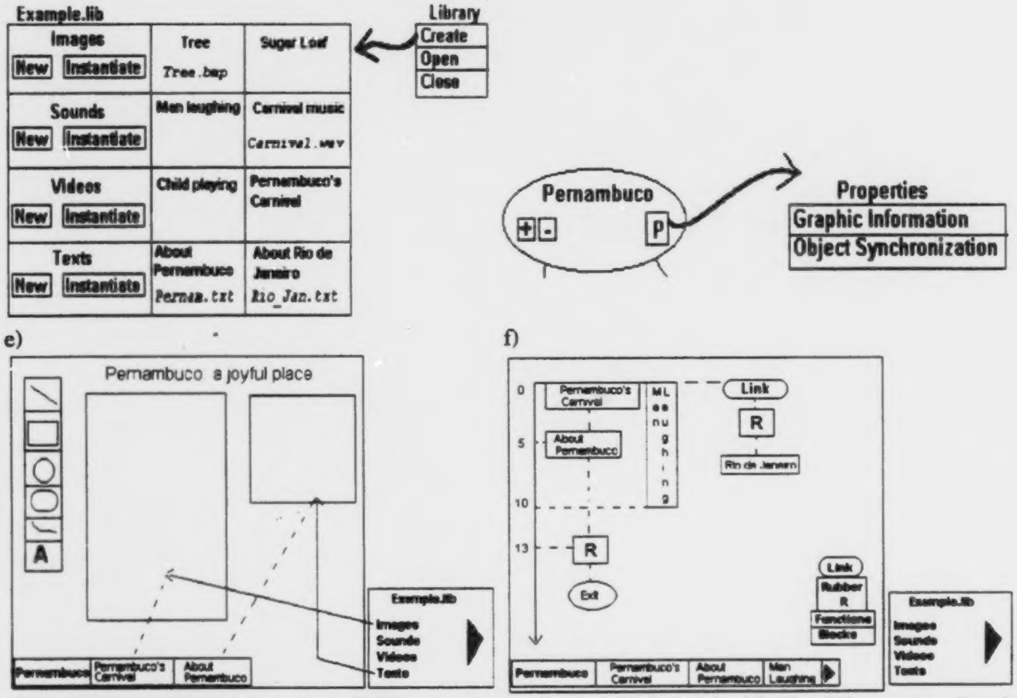
Example.lib
Images
New
Instantiate
Tree
Tree.bmp
Sugar Loaf
Sounds
Men laughing
Carnival music
Carnival.wav
Videos
Child playing
Pernambuco's Carnival
Texts
About Pernambuco
Pernam.txt
About Rio de Janeiro
Rio_Jan.txt
Library
Create
Open
Close
Pernambuco
P
Properties
Graphic Information
Object Synchronization
e)
Pernambuco: a joyful place
A
Example.lib
Images
Sounds
Videos
Texts
Pernambuco
Pernambuco's Carnival
About Pernambuco
f)
0
5
10
13
Pernambuco's Carnival
About Pernambuco
Men Laughing
Link
R
Rio de Janeiro
Exit
Link
Rubber
R
Functions
Blocks
Example.lib
Images
Sounds
Videos
Texts
Pernambuco
Pernambuco's Carnival
About Pernambuco
Men Laughing

Figure 1 The process of authoring of the proposed paradigm: a) Defining the blocks of the presentation; b) Determining a context of a block; c) Creating a library of multimedia objects; f) Options to work with a block; e) Defining the graphical information of a block; f) Defining the block synchronization.

6) Conclusions

In this paper we have presented an authoring paradigm that, unlike existing ones, focuses on the author as well as the final authoring application or product. We have shown through a comparison of some of the existing paradigms that there is no overall best paradigm, but that a suitable combination of these may produce better results. Core to this paradigm are the initial stages identified earlier, namely, the parametrization and project design phases. The proposed paradigm combines the use of icons, the time line and structured authoring. The next phase of this work is the evaluation, from users from the Visual Communications Department of The Federal University of Pernambuco of this proposed paradigm. It is hoped that their feedback will be used to improve it.

Because of the increasingly popularity and use of Internet, and trying to easy as much as possible the author's work we will also investigate the development of a high level search tool . That is, a tool devoted to look for elements (images, videos, animations, sounds, texts - not only home pages) on the Web under the input of a high level query (Ex: images and sounds related to animals). The implementation will use smart agents, which use and applications have already been under study by the other part of our multimedia and network research group, that is developing a smart agents platform [Garzotto, Paolini and Schwable 91a] over which this tool will run. The tool will be part of the authoring system helping the author on gathering the information and media objects needed to create a multimedia presentation.

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YOUNG LEARNERS AND COOPERATIVE AUTHORING

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Abstract: Considering hypermedia as processor ideas, we studied how twelve children play cooperatively the role of hypermedia documents authors. With this purpose, along two semesters, we developed different kinds of educational tasks supported by computers, providing children with general information about hypermedia and hypermedia tools. From weekly meetings with Windows, educational games, text and graphics editors and ToolBook authoring system, the children were became able to produce, in a collaborative way, a hypermedia document, called THE NATURAL ENVIRONMENT. In this paper, we report the study steps and analyze the children authoring process. Finally, we present the conclusions and further works.

I. INTRODUCTION

Hypermedia reproduces the human ways of storing and retrieving information by following referential links [Conklin, 1987]. Under this point-of-view, authoring and navigating processes are similar with the thinking building process. It means that new ideas are not built, one by one, in a linear fashion, beginning from nothing and concluding theirself in an established moment. Organization and representation of thinking is a process developed in many different frontages, through formulation, evidence and refutation of hypothesis, which depend and contribute in other hypothesis formulation. Understanding hypermedia as powerful idea processors, the purpose of this paper is to report and analyze how young children play the role of hypermedia documents authors.

II. HYPERMEDIA AND LEARNING PROCESS

According to Schank [1994], available educational software mimics what happens in schools. As schools everyday depends basically on didactic books, most educational software has a "page-turning architecture" [Schank, 1994]. This author understands that the "press the button for the next page" programs a very passive experience for the learners and not very educational. The reasons why this kind of software predominates in schools are related both with the lack of computing expertise and knowledge of latest theories of learning by the educational software designers. When designers have computing expertise, they do not know enough about teaching and learning techniques, reproducing current software educational models.

In spite of the large educational potentiality of hypermedia, Schank [1994] judges that it is faded to failure if they only incorporate video and figures to the traditional "page-turning programs". Consequently hypermedia programs can be either conventional tutors, or relevant cognitive tools. If the learner's presumed role is just to be a reader of hypermedia documents, it is just a conventional use with "new dressing". However, if the learner is author or co-author of the nodes and links network, hypermedia can be an important cognitive tool.

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Midoro [1993] sees a positive educational repercussion when hypermedia allows the use of the same interface for authors and readers. Same interface could enable cooperative authoring and the development of classroom project based on the use of available educational hypermedia and on the reuse of hypermedia material for new applications. Hypermedia could still be cooperative learning tools by excellence, since it allows hypermedia documents building with shared authoring among different authors - students and teachers [Holden et alii, 1992].

Once hypermedia programs can perform as idea processors, we have been using this kind of program with school first grades learners to make them to exercise self-expression, creativity, autonomy and cooperative work, by authoring hypermedia documents.

III. CHILDREN AS COOPERATIVE AUTHORS OF HYPERMEDIA DOCUMENTS

To analyze how children play the role of hypermedia documents authors, we developed a study aiming to find answers for two questions: (1) does hypermedia documents authoring stimulate cooperative work? (2) does the diversity of media supported by hypermedia authoring systems emphasize the self-expression, improving the use of other communication channels not explored in classroom (image, sound, animation)?

The study has taken place in an elementary school where the pedagogical approach is based on the constructivist philosophy, from august/1994 to august/1995, with 8/9 years old twelve learners. In the beginning of the study, the classroom was divided in 3 groups of 4 learners. Each of these groups took a 50 minutes class per week in school computer laboratory. Flávia Santoro, first author of this paper, has acted as participant observer, guiding the computer utilization, presenting educational software and helping to solve or to minimize the conflicts.

The study first step was to introduce computers, their devices and Windows® platform to the children. To make the computational environment familiar, during four months (August/December 1994) we used eight educational games, with which the students had to solve problems together in an entertaining way. After this introduction, we searched a straightest relationship between the computer tasks and the typical classroom work in a constructivist school. All school activities are developed from thematic projects and then, we took advantage of the project proposed for the first semester of 1995 - **Natural Environment** - for introducing hypermedia authoring.

To work cooperatively with a non familiar tool - a hypermedia authoring system, we believe that children must to handle easiest and most usual computational tools. So, we firstly introduced the children in a text editor (Creative Writer®) and a graphics editor (Kid Pix®). Our purpose was to familiarize them with text and figure edition in order to start the authoring process in a hypermedia environment. They quickly learned to write texts, joining texts and figures, using the software and Windows facilities.

The children acquired some expertise in handling Creative Writer® and Kid Pix®, producing collaboratively a newspaper, with several sections (sports, general notes, jokes and games). The next step was to presented them the Asymetrix Toolbook® 1.51 authoring system. From March to July of 1995, the children learned, in a learning-by-doing approach, how to use Toolbook® and how to build cooperatively a document in a non linear way, by linking text, figures, sounds and small available animation sequences.

We chose this Toolbook® version because it allows the use of hypermedia basic resources in a simple form. Both basic concepts of hypermedia and Toolbook® were taught at the same time. Whereas they were engaged in the semester thematic project, we proposed the cooperative authoring of a hypermedia document about the chosen theme. All of the 12 children agreed and they started to build the document, that they entitled *The Natural Environment*.

III.1 AUTHORING PROCESS OF THE NATURAL ENVIRONMENT HYPERMEDIA DOCUMENT

The authoring process first stage was a meeting with the children and their classroom teacher to select the topics to be included in the hypermedia document. They selected what they wanted to study about natural environment, creating a sketch of the nodes and links network to be developed. At the same time, they learned basic notions of Toolbook®, such as nodes construction (foreground and background), text edition, sounds and figures inclusion, buttons and links between pages creation.

The twelve learners divided themselves in 6 pairs, where each pair would research and bring to classroom material about two or three topics selected by them. Each pair has made researches about the theme at home and in classroom with their teacher. Collecting material and ideas, they organized what they learned in the format of hypermedia nodes, creating the hypermedia document sketch structure. Some pairs created links between their own topics and topics chosen by other pairs. The hypermedia document first page or cover page was created by one of the groups. This group created a table of contents page, just like an index, with the titles of each topic which could be linked to the respective pages created by other pairs. Moreover, hypermedia document common elements, such as pages background color and title, were defined by other groups. Topics that had some relationship were linked by buttons and return to previous page buttons were placed in all pages as well as in index page return buttons.

Files with figures chosen by children to compose some pages were built out of the school. Children just imported figures in pre-defined format. Sounds were introduced by buttons with a script already available in Toolbook®, in which they only had to inform the name of sound file. Sounds were recorded using Windows® Recorder, generating files in WAV format.

Developing the hypermedia document, children manifested great ability in dealing with Toolbook® basic functions. In spite of all ToolBook® menus and functions were displayed in English language (in Brazil, we speak Portuguese), and its non child specific interface, the familiarity with Windows®, reached with the use of text and graphics editors, provided the necessary safety to the successful and funny task development. A high degree of motivation persisted until the end of the task in all children and the groups interest and seriousness must be emphasized. The resulting of the work was a very interesting hypermedia document, made in child typical language, available for all scholar community consult, with proposals for further continuing and increasing..

III.2 AUTHORING RESULTS: *THE NATURAL ENVIRONMENT*

The hypermedia document developed by the children has a cover page and an index page from where all other pages are called. On figure displayed on the cover page, a big button was placed, making possible for the hypermedia document readers to access the index page. Button SAIR (exit) is present in all pages, permitting to exit the hypermedia document at any time. Children has catalogued all studied subjects in the index page and the subjects theirself are buttons which takes the reader to corresponding pages. All pages called by the index page have the button ÍNDICE (index), which takes the reader back to index page. In the page "Doenças causadas pelo lixo" (Diseases caused by garbage), for example, was placed a button called "Comportamento" (Behavior), which addresses the reader to page "Comportamento".

IV. ANSWERING THE STUDY QUESTIONS

As mentioned above, we are searching answers for two main questions: "Does hypermedia document authoring process stimulate cooperative work ?" and "Does the diversity of media provided by hypermedia authoring systems (images, sounds, animation) stimulate self-expression through communication channels not explored in conventional classroom ?". Let us now report our findings.

✓ Does hypermedia document authoring process stimulate cooperative work ?

Our proposal was strongly dependent of cooperation among involved children. We could observe that authoring process supported by hypermedia has provided and improved collaboration, since every information was always accessible for all children and could be increased and grouped by each one of them. Cooperation between pairs has gradually grown up along the work. In the first classes, it was hard to keep two children in front of the computer to play together an educational game. Some time after, they are managed in producing in group and seriously the hypermedia document. This aptitude is coherent with Piaget's theory which affirms that children at this age (8/9 years old) are facing an affective and cognitive transition, overcoming an egocentric behavior to achieve a greatest socialization and the desire for sharing tasks.

✓ Does the diversity of media provided by hypermedia authoring systems (images, sounds, animation) stimulate the self-expression through communication channels not explored in conventional classroom ?

We verified that young children did not have yet the written language "vice" as exclusive way of self-expressing. Hence, when they had other available communication ways, they managed to produce material creatively using also figures, sounds, and not only written information. Non linear disposition of information seemed to be very natural for children, presenting no difficulty in building and consulting their hypermedia document.

V. CONCLUSIONS AND FUTURE WORKS

Regarding that hypermedia systems can be powerful ideas processor, we analyzed how a group of 12 children from elementary school performed hypermedia document authoring process. We verified that non-linear writing and reading, supported by hypermedia authoring system, seem to be natural to these children. We also verified that the use of other media for self-expression (such as sounds and figures) is intuitively understood as one of the manner of real world representation, not restricted to written representation.

It is interesting to observe that along the authoring process, the cooperation among children and between pairs had increased. Learner's egocentric posture in the beginning of the work (August/1994) has changed to an effective and cooperative work at the ending (August/1995). This evolution is certainly not strongly related to the use of computers - learners were passing through a transition age (8/9 years old), however hypermedia document authoring mirrored this evolution.

At the first glance, the cooperation level among the 6 pairs could have been considered little expressive, since the hypermedia document was built from an index defined by the one of the groups and the other pairs have just created their pages and made links between them. The reality is quite different: we worked with young children (8/9 years old), which plays the role of authors in a hypermedia system. Subjects choices and implementation, screen's lay-outs (commons or not commons), background colors selection, pages sequence, buttons' formats and localization's performed with low disagreement indicate good cooperation level, especially when we consider the age of our children.

Future works are directed to profound studies about cooperative authoring. The current proposal is to develop most elaborated ways of cooperative works, integrating all children of the elementary school. The thematic project selected by learners for 1996 is Brazil's History. We have already chosen topics about this theme that children are more interested, and that are, at the same time, fundamental for their learning. Now, our challenge is to promote cooperative authoring among over 50 children (7-11 years old). We are facing this challenge trying to implement different cooperative authoring levels, according to children age. But we are sure that hypermedia will help us to be successful.

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The Knowledge, Skills, and Attitudes Needed in a CSCW Environment.

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Abstract: The final outcome of this study was the identification of the knowledge, skills, and attitudes that are needed to effectively work in a computer supported cooperative work environment (CSCW). A list of knowledge, skills and attitudes (KSAs) was obtained through the literature search and validated through the use of a panel of experts. The KSAs were put in to a survey instrument using a Likert scale to determine the optimal KSAs of new hires who will be hired five years from now. The survey was administered by mail to a population of individuals who recruit graduates of the University of Wisconsin-Stout. The instrument was mailed to a total of 379 valid respondents and 206 useable surveys were returned for a response rate of 54%. Eighteen key KSAs were identified.

Introduction

> *It shouldn't surprise anyone that human nature, good and bad, can throw a wrench into the best-laid IT (information technology) plans, yet technocrats are constantly caught off guard by the "irrational" behavior of "end users." In fact, people who are afraid of information technology have a good reason to feel that way. Companies that ballyhoo their latest management information systems or groupware usually spend little time training employees to use them* [Davenport 1994].

[Davenport 1994] stated that many organizations spend very little time training employees. Another study also found that much of the training was not effective as it was not solving the right problem [Rosenberg 1990]. One of the ways to develop a sound educational program is through the use of a well designed and systematic task analysis [Zemke & Kramlinger 1982].

In addition to not being properly trained, an interrelated problem is that people may not be effectively using computers. Two important trends presently influencing society are the use of collaboration and use of computers. The trend toward more collaboration is expressed in the increase of work groups, work teams, group learning, and other organizational changes that require cooperative efforts among individuals, groups, and organizations [Grudin 1991] [Firdman 1991]. The increase in the use of computers has grown as the price of computers has decreased and the power of computers has increased. These two trends have blended together to create collaborative computing or computer supported cooperative work [Grudin 1991] [Firdman 1991].

One probable outcome of this technological marriage is the electronic workplace - an organization wide system that integrates information processing and communications activities. The study of such systems is part of a new multidisciplinary field:

> *Computer-Supported Cooperative Work (CSCW). Drawing on the expertise and collaboration of many specialists, including social scientists and computer scientists, CSCW looks at how groups work and seeks to discover how technology (especially computers) can help them work.* [Ellis, Gibbs & Rein 1991].

An American Imperative [Wingspread Group 1993] challenged educational organizations to define the knowledge, skills, and abilities that are expected of learners upon graduation. A study [Schlough 1996] defined those competencies for students graduating from the University of Wisconsin-Stout (UW-Stout) as they relate to CSCW. UW-Stout is comprehensive university with an enrollment of approximately 7000 students. The mission and philosophy of UW-Stout emphasize academic programs that address the evolving economic, technical, and environmental demands of a global society and that seek to integrate technology, business, and service concepts.

Methodology

The study [Schlough 1996] was conducted with its primary purpose to ascertain the knowledge, skills, and attitudes (KSAs) for an individual to be effective in a computer supported cooperative work (CSCW) environment. The objectives of this study were to develop a system to analyze the elements of job performance of a worker in a knowledge based society and to identify the knowledge, skills and attitudes needed for an individual to work effectively in a computer supported work environment. This study also attempted to answer the several research questions.

A mail survey was sent to 394 individuals who had actively recruited University of Wisconsin-Stout graduates. Two hundred and six returned the survey for a response rate of 54%. The responses were tabulated, analyzed, and the following conclusions drawn from that data [Schlough 1996].

Conclusions

It was found that there were 18 KSAs that met the decision rule. This proved that the hypothesis was valid and the null hypothesis was invalid. The KSAs that met the decision rule are as follows.

- Work in a team.
- Value team activities.
- Value continuous improvement process.
- Function as a team facilitator.
- Understand basic communications principles.
- Value diversity.
- Appreciate the benefits of empowerment.
- Use forecasting tools.
- Value the appropriate use of computer technology.
- Understand team principles.
- Function as a team leader.
- Value the capacity to adapt to change.
- Appreciate the dynamics of change.
- Understand rate of change.
- Manage change activities.
- Function as a change agent.
- Understand total quality management principles.
- Determine leadership styles.

Conclusions based on the research questions are as follows.

What is the best way to analyze knowledge based work? Although this study does not give a definitive answer on the best way to analyze knowledge based work, several observations appear apparent. The first is that a through review, analysis, and synthesis of current literature is the most important step. It was also concluded that mail and telephone surveys are a means of collecting data and validating KSA statements. These conclusions will be elaborated on in the discussion of the process.

The next three research questions: What knowledge is needed to work in a computer supported work environment?; What skills are needed to work in a computer supported work environment?; and What attitudes are needed to work in a computer supported work environment? were answered in the testing of the hypothesis. There were eighteen KSAs that met the decision rule. A more interesting finding was that the three highest rated competencies were a skill statement (work), a knowledge statement (understand), and an attitude statement (value). From this, it could concluded that, if a competency is important, it is important that an individual obtains the knowledge, skill and proper attitude required to be proficient in that competency. The top three KSAs are as follows:

- Work in a team
- Understand team principles.
- Value team activities

When reviewing the question, "Is there a difference in the knowledge, skills, and attitudes needed depending on the type and size of organization?", it was discovered that even though there was some variance among subgroups that from a practical stand point it had little bearing. When using the decision rule of a mean score of 3.75 or greater, there were eighteen KSAs that met the rule in at least one subgroup that did not appear in the composite. Of these, they all had a composite mean score of 2.96 or greater, giving them a rating of average importance or greater. The KSAs in this category were:

- Generate business letters and research reports.
- Determine personality styles.
- Send and retrieve electronic mail.
- Create charts, graphs, and flow charts.
- Create and manipulate spreadsheets.
- Create presentation materials.
- Understand basic computer hardware technology.
- Search electronic databases.

- Plan a meeting.
- Share files over a network.
- Understand basic software design.
- Use calendar/scheduling software.
- Participate in a videoconference
- Understand basic computer networking principles.
- Understand computer networks.
- Create, sort, and query a database.
- Create multimedia presentations.
- Participate in a computer based electronic meeting.

The final research question, "Will individuals require different education, training, and professional development to work in CSCW environment?", is the most difficult to draw a conclusion on. It appears that most of the KSAs that are required are within the scope of normal education, training, and professional development activities. It appears that using an evolutionary approach to adopting CSCW will allow many existing courses, resources and methods to prepare workers to perform in a CSCW environment.

Discussion of the Process

The shift in jobs to more knowledge based work has proved to be a challenge for conventional task analysis techniques. Many of competencies required in the current work place are not observable nor performed in a repetitive manner. In an attempt to meet the needs of a changing work environment, this study investigated a variety of task analysis and needs assessment techniques to create a process to predict and validate future workplace competencies.

The process used in this study began with a comprehensive literature review of needs assessment, task analysis, and CSCW. The information gathered in this literature review was analyzed and synthesized with two main objectives. The first was to develop a process to analyze knowledge, skills and attitudes needed for employment. The second was to identify KSAs needed in CSCW environment. Using fifty of the identified KSAs, an instrument was developed to test the importance of these KSAs. This instrument was reviewed by a panel of experts and appropriate changes were made. The instrument was then field tested on a group of undergraduate students with senior status and graduate students. The database of the Career Placement Office at the University of Wisconsin-Stout was queried and sorted to create a report with 394 individuals who were classified as active recruiters of university graduates. The instrument was mailed to this population. A follow-up mailing was sent to those who did not respond to the original mailing. A random sample of those who did not respond to either mailing was selected and up to five attempts were made to contact them by telephone. Those who were contacted were asked to complete a abbreviated instrument over the phone. The data was entered and analyzed. From these results, recommendations were formulated on the process, the needed KSAs for CSCW, and how workers will obtain these KSAs.

This process appears to be a legitimate way to determine KSAs, as the mail survey validated the KSAs determined from the literature review and the phone follow-up showed no practical difference in the identified KSAs, although the demographics were slightly different. Overall, the process had few weaknesses and identified KSAs that would have been difficult to uncover through observation or interview techniques. It also reinforced the premise that knowledge and attitude are as important as skills to employers.

Based on the comments received, one weakness of the process seems to be that it is difficult to solicit accurate response on emerging technologies. Several of the respondents commented that they either were not aware of the technology or did not have an in-depth enough knowledge to accurately respond. Another weakness is that even though mail and telephone surveys are considered efficient methods to collect data, both are time consuming. Suggestions on the process for knowledge based analysis will be included in the recommendations.

Discussion on the KSAs Needed in a CSCW Environment

To determine if it is important to prepare future workers to work in a computer supported cooperative work environment, the study contained two questions that asked the respondents to rate the level of importance collaborative computing plays in their organization today and if they believe it would be more important in five years. The first was, "Of what importance do you believe collaborative computing plays in organizations today?". A total of 79% of the respondents gave a rating of average importance or higher.

When asked, "What importance do believe that collaborative computing will play in organizations five years from now?", 88% responded of more importance and 8% the same level and no responses indicated of less importance. There were 4 (2%) respondents who did not answer the question. The responses to these two questions indicate that the individuals responsible for hiring University of Wisconsin-Stout graduates believe that computer supported cooperative work plays an important role in their organizations today and will play a more important role in five years. This indicates that it is necessary for graduates to possess skills related to CSCW to be successful in this environment.

The respondents were asked to rate 50 knowledge, skill, and attitude statements on level of importance and respond yes or no if they felt that current university graduates they hired possessed these skills. Of the eighteen statements that met the original decision rule to be accepted as KSA statement, on only three of these statements did more than 75% of respondents reply that they felt current graduates possessed these KSAs. The highest positive response was 84% and the lowest positive response for KSAs that meet the decision rule were 31%.

When comparing this list to a previous study [Furst-Bowe et al. 1996] conducted in 1994 at the University of Wisconsin-Stout, several recommended computer competencies were not included.. This difference may be attributed to a more stringent decision rule used by this study. The 1994 study asked if a competency was important or not. If a competency was rated as important by more than 50% or more of the respondents from two of the three samples surveyed, it was considered important by the study. These competencies were formulated into a list of recommended competencies, using a team process. The recommendations were presented to and endorsed by a variety of campus leaders. Using 1994 study [Furst-Bowe et al. 1996] as a base, it seems appropriate to consider those KSAs that produced a similar status. Those KSAs are:

- Generate business letters and research reports.
- Determine personality styles.
- Send and retrieve electronic mail.
- Create charts, graphs, and flow charts.
- Plan a meeting.
- Share files over a network.
- Understand basic software design.
- Use calendar/scheduling software.
- Participate in a videoconference.
- Create and manipulate spreadsheets.
- Create presentation materials.
- Understand basic computer hardware technology.
- Search electronic databases.
- Understand basic computer networking principles.
- Understand computer networks.
- Create, sort, and query a database.
- Create multimedia presentations.
- Participate in a computer based electronic meeting.

The factor analysis also brought out one element that was not apparent in the other analyses. When examining the results of the factor analysis, factors 2 and 3 included KSAs that had rated high, team building and change management. Factor three included general computer skills that had received slightly above average ratings. Factor 5 contained two statements that were both rated low that were more specific computer skills and in all likelihood not KSAs that would be needed by most university graduates to succeed in CSCW workplace. Factor 1 was the most intriguing factor as it contained all KSAs that related specifically to collaborative technology. These KSAs all had mean scores that rated of average importance, with a range 3.27-2.82. Even though none of the KSAs met the original criteria, they deserve special consideration as they include the KSAs that relate directly to collaborative technology. [Burleigh 1989] cautioned to be alert to emerging technologies, as they often do not meet established criteria, when collecting data because many respondents may not have a full awareness of future needs. These KSAs with their mean score are listed in Table 1.

	Statement	**Mean Score**
42	Use group project management software	3.27
45	Use a fully integrated groupware package	3.1
44	Use group decision making software	3.06
46	Participate in a videoconference	3.01
47	Participate in a computer based electronic meeting	2.96
50	Lead others in the use of collaborative technology	2.96
49	Select appropriate technology for collaboration	2.93
48	Plan a technology based collaborative event	2.82

Table 1. KSAs with highest correlation using factor loading 1

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The data analysis, conclusions and discussion of these elements allowed the KSA statements to be explored in a variety of ways. By synthesizing, evaluating, and consolidating this information a set of recommendations was formulated, as to the KSAs needed in a CSCW work environment and how present workers and future workers may best obtain these KSAs.

Recommendations on the KSAs Needed in a CSCW Environment

The recommendations, are presented will with what was determined to be the optimal knowledge, skills, and attitudes using headings that were developed by consolidating statements and dividing them into categories focused around a theme with specific statements listed under each category. Statements in normal type met the original decision rule criteria, those in italic were rated of at least average importance and were added as part of the examination of the comparison data and/or factor analysis.

General Computing Technology
Understand basic communications principles.
Value the appropriate use of computer technology.
Generate business letters and research reports.
Create and manipulate spreadsheets.
Create presentation materials.
Send and retrieve electronic mail.
Understand basic computer hardware technology.
Create charts, graphs, and flow charts.
Search electronic databases.
Understand basic computer networking principles.
Create multimedia presentations.
Share files over a network.
Understand basic software design.
Create, sort, and query a database.

Team Building
Work in a team.
Understand team principles.
Value team activities.
Function as a team leader.
Function as a team facilitator.
Value diversity.
Appreciate the benefits of empowerment.
Determine leadership styles.
Determine personality styles.
Plan a meeting.

Change Management
Value continuous improvement process.
Value the capacity to adapt to change.
Appreciate the dynamics of change.
Understand rate of change.
Manage change activities.
Function as a change agent.
Use forecasting tools.
Understand total quality management principles.

Collaborative Technologies
Use calendar/scheduling software.
Participate in a videoconference.
Participate in a computer based electronic meeting.
Use group project management software .
Use a fully integrated groupware package.
Use group decision making software.
Lead others in the use of collaborative technology
Select appropriate technology for collaboration.
Plan a technology based collaborative event.

Examination of these competencies reveals that students have access to obtaining them through existing university experiences, if they are aware that these competencies are important and they are advised on how to obtain them. To accomplish this, a successful process that has been previously (Furst-Bowe et al. 1996) used is to make formal presentations, first to the Provost's Council at the University of Wisconsin-Stout, and then to the department chairs and program directors of each of the colleges. This process will make all major decision makers in the curriculum process aware of these competencies and the importance of them to the students of UW-Stout and their perspective employers. In addition to increasing the awareness of the need to obtain these competencies through existing experiences, it will be important to make certain that the use of these competencies is integrated into as many existing courses as possible to increase the students' potential to obtain multiple experiences relative to the KSAs needed to work in a CSCW work environment. This process should also encourage faculty to make use of collaborative technologies such as e-mail, computer based discussion groups, the World Wide Web and Lotus Notes to enhance the exchange of ideas in existing and future courses.

As the KSAs listed under collaborative technologies are not as widely used by faculty at the UW-Stout, a structured professional development activity should be developed around these KSAs and be made available to

UW-Stout faculty and staff. Even though the findings of this study were specific to UW-Stout, they should be generalizable enough that this activity would also be appropriate for other educators and members of public and private organizations. In addition, the findings of this study should be disseminated through articles and presentations.

Recommendations on the Process

The process used in this study should be appropriate to use to identify knowledge, skills, and attitudes in variety of settings were the work being performed is not readily observed. It is recommended that it is important to identify knowledge and attitudes in addition to skills, as all play an important part in today's workplace. A thorough literature review is paramount in the process to locate the KSA statements. In some situations, a literature review followed by an analysis and synthesis may be adequate. It is recommended that a mail survey be used to validate the KSA statements.

Summary

It is important to identify and update the knowledge, skills, and attitudes that individuals need to be successful in the workplace. Occupations are continually changing and educational institutions need to continually monitor those changes. This study specifically identified knowledge, skills, and attitudes that individuals need to perform in an environment were collaboration and technology are merging. It made recommendations as to specific knowledge, skills, and attitudes that graduates from the University of Wisconsin-Stout in five years should possess and recommendations on how they may best obtain them. Although these recommendations were specific to the University of Wisconsin-Stout, they should be generalizeble to a variety of settings as the responses came from a wide of array of organizations. Even though this study dealt with identifying knowledge, skills, and attitudes specifically for a computer supported work environment, the process used should be an appropriate model for analyzing competencies in a variety of settings .

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Creating Collaborative Learning Environments: The Challenge for Distant Learners

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Abstract: Technology exists to provide collaborative distance learning and training through electronic networks and groupware, yet little is currently known about appropriate ways in which to structure these learning environments. This paper describes a research project using groupware for collaborative learning activities. The project investigated the use of groupware for collaborative writing and problem solving with undergraduate students at a military academy. A structure for choosing such software and using it appropriately is offered. Finally, results and conclusions are presented about appropriate ways to support collaborative learning using computer networks and groupware with distant learners.

Introduction

Computer networks, a common feature of business, military, and educational settings, offer tremendous opportunities for groups to communicate. It is clear that they also present a manner in which to accomplish collaborative work and enhance distant educational experiences [Rohfeld & Hiemstra 1994] Technological advances have increased the expectations for distance learning; unfortunately, collaboration and interactivity are frequently lost in new electronic environments. Groupware, a new category of software, offers possibilities to enhance traditional communication, but thus far, examination of the potential has been focused in only a few areas. The potential for distance learning is worthy of more serious investigation.

This paper will discuss the use of groupware to support collaborative distance education and create interactivity between and among groups of learners, regardless of their geographic location. It will report on ongoing research conducted with students enrolled in courses at one military service academy. The researchers investigated the benefits, problems, and serendipitous results of groups working together using new technologies and software. The paper includes a set of characteristics with which to assess software and hardware needs, and a description of the processes by which groups use this type of network application. It concludes with recommendations for using groupware to support collaborative activities, regardless of the geographic locations.

Perspectives from Literature

Traditional distance learning environments were based on correspondence through passive media (paper, audio and video broadcast) and were frequently conducted as independent experiences, with each learner corresponding only with the instructor. Recent developments in network and communication technologies have offered the opportunity to improve these environments through increased communication, interactivity among participants, and incorporation of collaborative pedagogical models.

Groupware refers to software that supports and augments group work, however, most investigations have focused on those capabilities useful in business settings, particularly among co-located populations who used the software synchronously, often in group decision activities [Valacich, Dennis, & Nunamaker, Jr., 1991]. The literature is now beginning to expand the conceptualization of the use of groupware to include asynchronous and geographically distant activities.

It has become clear that technology has the potential to change the way in which people behave, according to Lea and Spears [1991]. They identified a change in informal and formal talk, and individuals' loss of identity and de-individuation. Tatar, Foster and Bobrow [1991] suggest consideration for what group work really means. It is not just individuals working at computers at the same time, but it means "giving participants the ability to judge when it is appropriate to overlap, just as they judge the efficacy" of adding to verbal conversations [1991, p. 77]. It is necessary that group members learn and act out their roles in these situations [Olson & Bly, 1991].

Learners report greater control and responsibility toward their learning; students also find that the act of writing demands greater reflection than speaking [Harasim, 1990; Rohfeld & Hiemstra, 1994]. Several research and anecdotal studies have looked at online components of traditional courses and have concluded that these components substantially increase the communication between the teacher and the students, and among the students, when compared with similar writing classes without the computer communication component [Hartman, Neuwirth, Kiesler, Sproull, Cochran, Palmquist, & Zubrow, 1994; Hiltz, 1990; Schrum, 1995a].

Regardless of the medium, electronic communication appears to foster collaboration and group interactions. In a study of distributed research, in which individuals who were geographically distant from each other collaborated on a research project, Olson and Bly [1991] concluded that

> interpersonal computing supports people communicating and working together through the computer; it includes tools to support interaction separated by time and/or space as well as face-to-face interaction and meetings. ... Work forced the boundaries of social place to extend beyond the boundaries of physical place. [p. 81]

Recent research on groupware suggests that, in using tools such as hypertext, "aspects of group 'process' have become tightly integrated in (if not inseparable from) the resulting 'product' of the group" [Oravec, 1996, p. 80]. In a study of group activity, Olson and Olson [1996] compared controlled activities for groups using groupware and those meeting face to face. They examined three outcomes, satisfaction, quality and process, and report that those using the groupware were less satisfied, remarked on the lack of group interaction, and yet the quality was higher in the computer groups.

Leadership is also an important issue in using groupware, especially in the context of this research. Recent studies suggest that typical leadership styles may not work in the same manner in a networked environment, as Oravec summarized,

> Effectiveness of various leadership styles may differ with group characters; for example, charisma may be critical in leading a spontaneous, real-time brainstorming session but other, less flamboyant styles may be more effective when detailed backstage planning and consensus building are required. [p. 81]

Many questions remain unanswered about the use of groupware and networks for learning collaboratively, and perhaps it is insignificant whether the participants are geographically separated or co-located. For the purposes of this study, we chose to begin with co-located learners, to have better control over the environment and to monitor the hardware and software.

Research Design and Methods

These research projects were created to determine the viability of using groupware to support collaborative writing and problem solving within the context of already planned and assigned projects within courses that meet in a traditional face to face model. A military service academy represented a unique opportunity to study such uses, because all participants had access to high end technology. In addition, group projects are frequent yet most cadets have reported disliking them, possibly because they rarely have the possibility to work together on group projects. Researchers recruited the professor of a summer class to participate in the pilot projects.

After study of many groupware packages, researchers and personnel at the Service Academy determined that LotusNotes would be the most desirable choice for the various experiments. Once this decision was made, effort was expended to create scenarios and job tools, and ascertain hardware requirements for successful implementation.

Methods

Methods that were planned included Likert type pre- and post-test surveys of all participating students, electronic and on-site observations, semi-structured interviews with randomly selected participants and the instructor, and analysis of transcripts of group process work. Data analysis included statistical analysis of the pre- and post-tests, content analysis of the observations, interviews and transcripts of group processes. The qualitative data were coded by the researchers individually and then the researchers compared and synthesized the results. The utilization of multiple methods and peer interaction was designed to triangulate the research perspectives and increase the understanding of the participants' perspectives and response to the activities using groupware.

A case study approach is also an appropriate manner in which to investigate this type of emerging phenomenon, particularly in a situation that is evolving and in which it is important to ascertain the participants' understandings of the processes. Qualitative methods "are a source of well-grounded, rich descriptions and explanations of processes occurring in local contexts" [Miles & Huberman, 1984, p. 15]. This course represented a challenge for traditional research methods, especially considering that conducting research using ethnographic techniques via an electronic format is a fairly recent possibility; to do so in an ethical manner is an even greater challenge [Schrum, 1995b].

Efforts were expended to triangulate the data sources and methods, and to include all possible opportunities to understand the experiences from as many perspectives as possible; these included analysis of written documents and group discussions, individual perspectives, and community memories [Lincoln & Guba, 1985; Miles & Huberman, 1984]. The text exchanges, lessons, and responses were captured for analysis. Individuals were invited to participate in individual electronic or telephone interviews that were designed to investigate the program processes, document variations among and between participants, and sought to understand and describe the events and resulting impacts from this course. These semi-structured interviews were conducted using naturalistic inquiry. The qualitative data were coded by the researcher and then compared, analyzed, and synthesized based on emerging themes.

Additionally, an evaluation survey was conducted using Likert-type scales and allowing anonymous responses. Respondents were asked to indicate their agreement on each statement across four options. These evaluation surveys were computed for means and percentages to understand participants' responses to the conferencing software, the study guides, and the online communication experiences. Descriptive data were also collected from the participants.

The questions with which we began these research investigations included:
What were the pedagogical strengths and weaknesses in this environment?
What benefits and difficulties did participants report when using groupware for collaborative writing?
What incidental or serendipitous learning occurred while using groupware for collaborative learning?

Research Projects

Project Alpha Description

The class, a mandatory course focused on leadership, had twelve students. These students were enrolled during the summer primarily to reduce their fall semester load, for either sports or flight activities. The class met 15 times, for three hours per meeting. These students were all comfortable with computers, with electronic communications, and with group projects, however none of the 12 had previously used groupware.

The first pilot consisted of students entering a networked computer lab, but having no previous information about their intended activity. They were given a brief introduction to LotusNotes. Then they were randomly assigned to groups of four and were given three hours in which to collaboratively write a paper describing a policy decision that was unpopular and ways in which leadership might respond to this circumstance.

During this pilot the students were given three hours in which to complete the task. Unfortunately, the hardware and software posed enormous problems for the students. Computers crashed, the software refused to allow printing, and in total the perception of the groupware was largely negative. In spite of these difficulties, the groups did produce a collaborative paper, and managed to complete the assignment on time.

Project Bravo Description

The twelve students were divided into three groups of four students each by the instructor. Their task was to visit an organization in the local area, either a business or other enterprise, identify its organizational culture and leadership patterns, and then to collaboratively write about their experience. They were to assess the situation as they saw it, and to analyze the organization with respect to the leadership attributes they had studied. They were again asked to use LotusNotes in the networked computer lab to complete this project, and they again had three hours in which to accomplish this. One of the groups completed this task on one day and the other two groups completed this task on a separate day.

Results

Unfortunately, the researchers feel that the difficulties encountered severely compromised much of the statistical data. Given the difficulties with the hardware and software, and the artificial nature of the assignments, expectations were not extremely high. Nevertheless, data were generated and information was gathered that proved important and informed the planning for the next set of projects. Many things became clear during these pilots.

Overall, an electronic network did enable collaborative and group activities. Interaction was fostered and students were individually, responsible and accountable for that interaction, and for the ultimate product. Strategies to accomplish the tasks were identifiable.

Group Dynamics and Process

Leadership patterns and roles emerged although it is unclear how the nature of the task impacted these roles. Each group began its assignments with a flurry of messaging, which tended to promote a "division of labor" collaborative writing model, and a good deal of humor. The initial activity appeared to be an organizational phase, in which they all participated. Some volunteered for tasks ("I'll do the body") and other tasks were assigned by skills, for example, one cadet was assigned the task of "turning it into English." After they brainstormed and designed their strategies, it was clear that they then individually worked to actually gather resources and begin their writing tasks.

Technical Difficulties

From the observations, interview comments, and transcripts, it was clear that the students felt that they could have more easily accomplished the task without using the network and groupware, or could have used the network with electronic mail and attachments. They also felt that even if the technology had worked perfectly it would not have been better than their traditional manner of group work. The reality of the situation (participants sitting in one room with multiple researchers observing them) and the artificial nature of their task (to accomplish something using technology that would have been easier done by talking) was disconcerting.

Yet, despite the difficulties, the groups reacted with enormous patience, even during 30 minute computer downtimes. They were not concerned that their deadlines were fast approaching, and the system was worthless, or that they could not print their report. A few individuals did show signs of stress and frustration (slamming a mouse on the desk, demonstrating symptoms of discomfort, or being off task). For the most part, however, adaptive behaviors dominated. They reverted to their word processing and electronic mail systems, when all else failed.

From these pilots and other investigations, it is also clear that tasks given to learners must be relevant and authentic. Imposing quiet on the participants would have assisted with the experiment, but would have been difficult and increased the artificial nature of the task, not to mention that this may have interfered with their learning. Equally onerous for the students was the researchers' use of video cameras; this was mentioned by all those who were individually interviewed.

Beyond the nature of the task, a great deal was learned about the planning and support necessary for actually carrying out a project using groupware. First, technical support is essential. All components of the technology must be running smoothly, operationally sound, and those hardware glitches that can be identified as potential hazards must be resolved. Choosing a software package that can accomplish necessary tasks, given the nature of the learning

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experience, and yet not overwhelm the participants and support system is a delicate balance. Additionally, sufficient time must be allowed for learning and experimenting with the groupware.

Second, it is clear that all personnel have a stake in the success of the project. This ownership of the project is essential if individuals are expected to learn new skills, to provide timely assistance, and to tackle difficult problems. Third, it would be extremely helpful to determine which participant prerequisites (for example, knowledge and skills of computer applications) are significant to the success of the activity.

Putting together lessons from these experiences, the literature and other communications [Barrows, 1995; M. Guzdial, 1997, personal communication) the researchers began to identify support structures for geographically separated learners. It became clear that some activities are logically completed collaboratively (brainstorming, identifying the problem, choosing the place to begin, designing a solution, and testing out that solution) and others for which groupware and collaboration are not particularly useful (constructing and writing documents). Those creating such projects would be wise to structure activities with organizers and frameworks that encourage learners to explore ways in which the tools actually enhance their work. Giving learners control and support for self-determination of appropriate uses will accomplish the goals more successfully.

Conclusions

Distance education represents a step toward lifelong learning so individuals can maintain professional expertise, share information, and work collaboratively. Technology can support these goals with interactive networks and groupware, which allows synchronous and asynchronous discussions, collaborative activities, and group decision making. This research looked carefully at the emerging phenomenon of online and collaborative learning.

These research efforts represent a first step at investigating the use of groupware for collaborative learning experiences. This paper described one distance education course, delivered using an Internet and web based groupware product, from the perspectives of the students and instructor. It also provided information about the viability of groupware for collaboration within a single course setting to accomplish new activities, and identified activities that are inherently best done as a group and others that are more easily and appropriately accomplished individually.

These studies demonstrate that groupware holds potential for interactive collaborative learning, and distance education for many activities, but is not completely successful for all learners in all situations. The researchers, using information from this and other studies, created a framework to identify applications of groupware, which include education, business, and research.

Lessons learned from these experiences have informed planning for using groupware, and assist instructors in creating viable courses and assignments for both teaching and learning. Results suggest positive outcomes for content learning, and some strong suggestions for improving the structure and process of this type of online activity. Further research is needed to provide more information regarding best practices in using groupware for content specific learning, collaborative problem solving, and group processes.

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Challenge-Driven Learning:
A Model for Children's Multimedia Mathematics Learning Environments

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Abstract: Many children have difficulty learning mathematical subjects and are not motivated to study mathematics. To make learning mathematics an enjoyable activity for children, this paper proposes the use of a certain model for designing multimedia mathematics learning environments. In this model, learning of mathematics is a dialectic process between challenge and knowledge building. One implementation of this model is presented, and the preliminary results of a study that was conducted using this implementation are presented. The results indicate that this model can help educators design learning environments which can be very effective in helping children learn and enjoy mathematics.

Introduction and Background

Many children find learning mathematics difficult, irrelevant to their lives, and boring. This paper presents a model of multimedia mathematics learning environments, focusing on the dynamics between challenge and learning, that addresses this problem.

The difficulty in helping children to learn mathematics is twofold: 1) to motivate them to want to spend time and engage in mathematical activities, and 2) to aid them cognitively to construct mathematical knowledge.

Electronic games are an integral part of the social life of children [see Provenzo, 1991]. Well-designed mathematical computer games can meet some of the psychological needs of children and motivate them to want to learn mathematical subjects [see Sedighian & Sedighian, 1996]. Malone [Malone, 1981] studied children's fascination for non-educational electronic games to find out what makes these games fun and enjoyable. He found that electronic games had certain features in common: they provided a feeling of control in children, they made children curious, they provided both intrinsic and extrinsic fantasies, and they challenged children. Based on these and follow-up studies, Lepper and Malone [Lepper & Malone, 1987] suggested the use of computer games as possible means for instructional activities.

On a broader conceptual level, since the 1960s, Csikszentmihalyi and his colleagues [Csikszentmihalyi, 1975; Csikszentmihalyi & Csikszentmihalyi, 1988] have been studying the nature of happiness, joy, anxiety, and boredom. In their theoretical model of enjoyment, they describe *flow*, an intrinsically motivating and rewarding state in which an individual derives optimal experience from an activity. "Games are obvious flow activities, and play is the flow experience *par excellence*. Yet playing a game does not guarantee that one is experiencing flow, . . ." [Csikszentmihalyi, 1975, p. 37]. Flow activities have certain structural characteristics [*ibid.*; Norman, 1993]. One of these characteristics is a balance between challenge and skill. Csikszentmihalyi [1988] states that "optimal experience requires a balance between the challenge perceived in a given situation and the skills a person brings to it. . . . To remain in flow, one must increase the complexity of the activity by developing new skills and taking on new challenges. . . . Flow forces people to stretch themselves, to always take on another challenge, to improve on their abilities" (p. 30).

One of the most challenging tasks in producing a sustainable, intrinsically motivating activity is to keep the ratio between a person's capabilities and encountered challenge within a range which results in neither boredom and lack of fun nor worry and anxiety. When the challenge is greater than one's capabilities, one experiences worry and frustration; when one's skill is greater than the challenge, one experiences boredom [Csikszentmihalyi, 1975, p. 49]. Csikszentmihalyi [Csikszentmihalyi, 1988] suggests that one of the urgent applications of the flow theory is in education. Before presenting an application of this theory, however, it is important to consider some of the cognitive aspects of learning.

As stated before, mathematical computer games can engage children in mathematical activities. However, such engagement, by itself, is not enough to fulfill the learning and instructional needs of children. Insightful learning requires conscious reflection upon one's performance and problem solving [for example, see Van Lehn, 1991; Klahr & Dunbar, 1988]. Norman [Norman, 1993] emphasizes and discusses at length the importance of reflective cognition in meaningful learning, and laments that the current state of educational technology indicates its ignorance of this cognitive issue. Most educational games do not force children to reflect on the underlying mathematical concepts and consciously and thoughtfully react to the mathematical challenges that arise in the game. Reflective cognition is hard work, and if a tool is not designed properly, it can cause frustration and lack of interest in learning, and in some cases even repulsion. "Multimedia for education must minimize the fluff and get the users working -- working hard, not because they have to but because they want to" [*ibid.*, p. 41].

A fundamental question to be addressed is: How should a learning artifact be designed so that it actively promotes reflective thought while not compromising the characteristics of a flow activity? In the following section, a model of such a system is briefly presented. This model combines and integrates the aforementioned ideas and applies them to a multimedia mathematics learning environment. Afterwards, one implementation of this model -- *Super Tangrams* (*ST*) -- is presented, and the results of a study that was conducted using *ST* are reported.

The Model

In the flow model challenge and skill are generic parameters. When these parameters are mapped to a mathematics learning environment, challenge and skill respectively become: required mathematical capability, and newly constructed or acquired mathematical knowledge. Keeping the balance between the required mathematical capability and the child's knowledge is the key to sustaining his/her interest in the learning activity. Therefore, in this environment, learning becomes a progressive dialectic process in which required knowledge (i.e., challenge) and constructed knowledge (i.e., skill) interact and are kept in balance.

The model presented here is hybrid; namely, it consists of two main components: 1) a game module and 2) an embedded instructional module.

The game module is intended to provide a motivating environment for children to engage in mathematical activity, and a context in which children "experience the enjoyment of goal-directed action" [Csikszentmihalyi, 1988, p. 34]. The mathematical activity of the game should ideally deal with a specific and limited domain of knowledge. The game should have a series of well-defined sequential goals. These goals must progressively become more challenging. This challenge should preferably be spread over a number of levels, not only to give children a sense of accomplishment but also to provide them with an indication of how much further they have to go to "beat the game."[1] Naturally, the game should be designed such that to advance through it, children must pay attention to finer and more specific conceptual details and continuously increase and refine their understanding of the embedded mathematical domain to meet the challenges that arise in the course of play. This increase in the degree of challenge is directly proportional to the children's need for increased reflective thought – an essential requirement for deep learning.

The instructional module is intended to allow children to increase their mathematical knowledge. Ideally, this module should not automatically interrupt the flow of play based on pre-determined measures put in by the designer of the environment. Rather, the instructional component should be invoked by children at will, any time they desire. The reason for making the instructional module an on-demand activity is that most children do not like to learn mathematics unless it satisfies a need [for a discussion on children's need for learning mathematics, see Skemp, 1986]. In order to satisfy the need of accomplishing the goals of the game, children have to meet the challenges presented to them. To meet these challenges they have to learn the mathematical concepts that are embedded in the game activity. Therefore, the instructional module must be closely linked to the goals of the game and allow children to construct the knowledge required to move through the game. To keep the ratio between challenge and knowledge construction such that children experience flow, the instructional component must be adjusted to the knowledge requirements of where the player is in the game. Hence, as the game becomes more challenging and knowledge intensive, the instructional module must likewise provide a more sophisticated conceptual presentation of the mathematical domain.

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[1] As children themselves put it.

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Super Tangrams: An Implementation of the Model

One implementation of the aforementioned model is to be found in a computer-based mathematics learning environment called *Super Tangrams*. *ST* is aimed at helping middle-school children learn two-dimensional transformation geometry. It is designed to take children from no knowledge of transformations to a fairly sophisticated understanding of the subject for this age group.[2] Learning of this mathematical domain is situated in the context of the traditional tangram puzzles game activity. The player is challenged to put together several geometric shapes to fit a given outline. Shapes are moved by applying three transformations to them, namely, translation, rotation, and reflection. In order to play, children have to know transformation geometry, and, as a result, acquire the need to learn the subject. In this section, I focus on the structural characteristics of *ST* that make it a challenge-driven learning environment and an educational flow experience. Other features of *ST* as well as the reasons for its development have been discussed elsewhere [Sedighian & Klawe, 1996b].

There are six factors in *ST* that intensify the challenge and force increased reflective thought in children: 1) the different levels; 2) the user interface; 3) the scoring scheme; 4) the accessibility of the transformations; 5) the order of the puzzles; and 6) the initial configuration of puzzle shapes.

Different levels: *ST* has 40 puzzles divided into 3 levels.[3] *Level 1* starts in an introductory manner so that virtually all children can initially be successful and learn the basic operations of both the game and transformation geometry. *Level 2* becomes more difficult requiring children to pay greater attention to the underlying mathematical concepts. *Level 3* is very complex and requires quite a sophisticated understanding of transformation geometry.

User interface: The user interface in *ST* plays a central role in making it a challenging and reflective learning environment [Sedighian & Klawe, 1996a]. Most children come to *ST* with either no knowledge of or a very limited and naive understanding of transformation geometry. Children are usually accustomed to moving shapes by manipulating them directly. In contrast, in *ST* children have to move the puzzle shapes by adjusting and manipulating on-screen formal interface representations of the transformations (i.e., a translation arrow, an arc of rotation, and a line of reflection). This is initially challenging and requires children to shift from an intuitive to a more formal understanding of transformation geometry. Figure 1 shows how a line of reflection is used to flip a shape -- two handles are used: one to adjust the angle of the line of reflection and the other to adjust the distance of this line from the shape which is being reflected. In each level some of the interface components fade and feedback is reduced thereby putting increased cognitive responsibility on children.

Scoring scheme: Each puzzle can be solved using a minimum number of transformations or moves. Furthermore, each puzzle is assigned a predetermined maximum score which is obtained only when a player solves a puzzle using the minimum required transformations. Extra moves cost the player some points and lower the score. This forces many children to spend considerable time thinking about and determining how to transform the shapes in the fewest number of moves. Puzzles in *Level 3* have very high maximum scores compared with those in *Level 1*.

Accessibility of transformations: Certain transformations or combinations of transformations are easier than others. By restricting the accessibility of certain transformations at different stages of the game, children are forced to understand alternative ways of solving the puzzles. An instance of this is when they are given only reflection to solve a puzzle making the problem much more challenging mathematically than if they are given both reflection and translation.

Order of the puzzles: Puzzles are ordered in such a way as not to distract children from the main objective of the program, which is learning transformation geometry. By this is meant that when the aim of the puzzle is for the child to learn the basics of a transformation concept the tangram puzzle itself is not difficult to solve – sometimes even single-shape puzzles are used. However, as soon as children pass beyond the basics, the tangram puzzles themselves become more complex.

Initial configuration of puzzle shapes: The initial positions of the geometric shapes in each puzzle are carefully chosen so as to create different degrees of challenge. Sometimes a shape is placed so that it can simply be translated to its final position, and sometimes composite reflections are needed to get a shape to its desired destination.

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[2] An example of what a child is expected to do during play is to determine the angle of rotation and estimate where the center of rotation should be placed in order to move a particular shape to a desired position. This understanding of rotation is not usually expected from students until late in their high school education.

[3] These numbers can be changed depending on how thoroughly the mathematical subject needs to be treated.

To assist children to overcome the challenges faced in the game and stay in flow, *ST* provides them with a *Learn* module. The presentation of concepts in *Learn* is closely tied not only to the mathematical concepts in the game but also to the goals of the game. The *Learn* module can be invoked at any point during a playing session. It has two main features: 1) direct instruction and 2) interactive practice.

Direct instruction: This is an audio-visual teaching component which explains transformation geometry concepts found in children's mathematics textbooks using pictures, text, and voice. Children can activate pop-up windows which are accompanied by voice explanations of the displayed concepts, such as the properties of rotation. Children can invoke these windows any number of times and can exit them at any time.

Interactive practice: This is an interactive multimedia environment in which children can learn and practice the concepts in the game for as long as they want without losing any points. The representation of mathematical objects is identical to those in the game. Children can click on a number of sound icons to listen to explanations of how a transformation works while simultaneously manipulating its on-screen interface representation. The purpose of this feature is not only to assist children to see the consequences of their actions in the light of formal explanations, but also to allow them to gain the required knowledge to meet the challenges in the game. The interface representation of the mathematical concepts as well as the sound icons change for each level to correspond to the needs of the game at that stage. In addition, the sound icons do not simply explain mathematical concepts in a dry manner; in some instances, children are encouraged to learn a concept by statements such as: "This level is for masters of Super Tangrams. Only players who have mastery of transformation geometry can pass this level. So, pay close attention to what I have to say." Figure 2 shows the practice feature of *Learn*.

Figure 1: A puzzle in *Level 1* of the game.

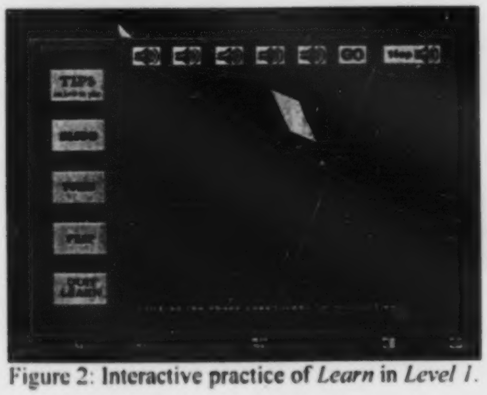

Figure 2: Interactive practice of *Learn* in *Level 1*.

Results

A pilot study was conducted with a version of *ST* which did not have the *Learn* module. Initially, children were quite excited about the program [Sedighian & Klawe, 1996b]. However, as the challenge in the game component started to increase (towards the end of *Level 1*), many children, except for a few who had adult mediation while playing the game, became frustrated and gradually lost interest in the game.

Later on the model of *ST* described in this paper was completed along with several other design variations of *ST*, and a larger study was conducted to evaluate the educational effectiveness of the variations. The study was a quasi-experimental design comprising of a Pretest-Posttest Comparison Group Design and a Posttest-Only Comparison Group Design followed by qualitative interviews. A total of 116 students from five grade-6 classes participated in this study. The students were given pre- and post-tests to measure their knowledge of transformation geometry and their attitude towards the subject. They were also given questionnaires about *ST* which inquired into what they thought they had learned from it, how much they liked it, how they used it, and

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so on. The students were divided into seven groups, each receiving a different treatment (treatments were based on different variations of *ST*). The students in each group were paired and allowed to work with *ST* for ten sessions of approximately 35 to 40 minutes each. The groups were videotaped during several of the sessions. After the post-tests were administered, 20% of students from each group were interviewed. One of these groups (Group 1; 15 students) used the version of *ST* described above. Another group (Group 2; 14 students) used a version which was different from the former in the following ways: 1) it only had one level, 2) the user interface and the contents of *Learn* stayed the same throughout the game, 3) the scoring was not dependent on the number of moves, and 4) all transformations were accessible at all times.

There was approximately a 50% improvement in the average achievement scores of the students in Group 1. By comparison, there was approximately only a 15% improvement in the average scores of the second group. All students in Group 1 had used *Learn* , and 87% of them had stated that they could not have progressed through the game without using *Learn*. This is in sharp contrast to students in the second group none of whom had used *Learn*, and all had said that they could progress through the game without *Learn*. The log files recorded by the program show that some students in Group 1 had spent more than 25 minutes of a session in the *Learn* module compared with 10 to 15 minutes in the game. Below is a list of some typical comments about *Learn* made by the students from the two groups:[4]

Group 1	Group 2
1. I did [use *Learn*] because you don't lose points learning. [It is good to have *Learn*] because then you might get stuck alot.	1. I did not see it [the *Learn* button]. [It is not good to have *Learn*] because we did not have to use it.
2. I didn't understand what I was doing until I went to *Learn*. I also think that the sound icons were very useful. [It is good to have *Learn*]; other wise you will get stuck and will not know what to do.	2. I did not notice it. I did progress through the game without using *Learn*.
3. I would have never completely understood motion geometry without it [*Learn*].	3. What is *Learn*?
4. [*Learn*] helps people who don't know motion geometry learn it to play the game.	4. We just didn't seem to need it and we didn't pay much attention to it being there.

The students in Group 1 were often observed to be totally engrossed in the activity. When questioned whether they minded that they had to get out of the game activity to learn a concept to be able to continue with the game, many of them stated that it helped them understand the subject better, that they enjoyed the learning because they could apply it directly to what they were doing in the game, and, as a result, could move faster through the game and get a better score.

Conclusions

A model of multimedia mathematics learning environments has been presented in which children become engaged in the learning process through a challenge-driven, goal-directed activity. This model has two main components: a game module and an embedded instructional module. An implementation of this model, *ST*, has also been presented, and the results from the studies conducted using this implementation have been briefly reviewed. The results presented compare the achievements of only two groups. The achievement scores of a third group of 29 students, whose *ST* version was identical to that of Group 1, but additionally received adult intervention, increased on average by more than 52%. These results indicate that an application of this model can help children learn mathematics while really enjoying the learning process.

A number of points have been identified which seem to be crucial for making implementations of this model educationally effective and successful:

1. the game activity must be highly goal-driven and have clear rules of play so that children are at all times *intensely* focused on achieving the goals of the game;

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[4] All comments are direct quotes from the students.

2. children must continuously receive feedback that is directly linked to the goals of the game;
3. the game must gradually become more challenging and reflective while at the same time providing an instructional component in order to sustain the *flow* experience;
4. to prevent frustration and boredom in children, the dynamics between the game and the instructional component must be fine-tuned; this allows children to receive appropriate instruction for the type and level of the mathematical problems they are solving.

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Java for Educational Simulations: Saboteur or Saviour?

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Abstract: The use of Java as a platform for the construction and delivery of Educational Simulations is considered. Some essential characteristics of simulations are defined with the help of examples. I then explore how effectively Java supports these characteristics by describing the re-implementation of an existing simulation which has been built in several other object-oriented programming environments.

1 Introduction

1.1 Educational Simulations

A educational simulation is a computer based system which brings together a model of some real situation and a graphical representation of the model's output, such as a graph or a moving image.The simulation program allows the user to vary the parameters of the model and then generates its output by running the algorithm across a range of values of a chosen independent variable. For example, Steamer [Hollan et al. 84], a simulation of the powerplant of a large ship, contains a mathematical model of the powerplant's boilers, turbines, heat exchangers and other components. Steamer 's graphical interface shows a schematic display of the system and allows the user to vary parameters and observe the corresponding operating values.

In general, simulation programs conceal their underlying model from the user behind an interface which allows them to vary parameters and observe results. The focus is on the interpretation of these results and their comparison with reality. This leads to different kinds of learning experience from those fostered in modelling systems such as Stella [Richmond et al. 87] or the Dynamic Modelling System [Ogborn & Wong 84]. As one author puts it: "...simulations tend to emphasise the issue of the simulation's fidelity to the real world whereas modelling emphasises the exploration of the consequences of the model." [Brna 91]

Educational simulations have an established role within the area of Computer Assisted Learning where they have been used for many years. The construction of an effective simulation requires three distinct kinds of effort. First, the simulation designers must possess a depth of knowledge on the topic to be treated. They need to be aware of the key concepts, of possible algorithms, the availability of empirical data and so on. Second, consideration must be given to the design of the user's interaction with the software. The most obvious aspect of the interaction is the interface, of course, but as Don Norman [Norman 93],[Norman & Draper 88] among others has pointed out, designers also need to take account of the user's task context, the mode of operation, and a host of other factors external to the actual software. The third and final area of effort is the implementation of the design - the specification, coding, testing and refining of the software package and the production of documentation.

The choice of implementation language inevitably has an effect on each of these stages. Sometimes the effects are obvious - for instance, a particular language might simply be too inefficient to run a complex algorithm. But more subtle effects can also cause trouble. For example, the rise of the Internet is forcing software designers to take account of multi-processing, that is, to be aware that their programs may have to cooperate with other processes running on the same computer. Some languages offer little or no support for this state of affairs. In the following sections I will examine these and other issues.

1.2 Programming Languages

Educational simulations have been built in many different programming languages. I have already pointed out some technical ways in which the implementation language affects a design, but the choice is often mediated by more practical concerns, such as the availability of skilled programmers, or the existence of a compiler for a particular computer platform. Furthermore, to save wasted effort, simulation designers often wish to take advantage of existing libraries of code. The way the programming interface to such libraries is expressed (for example, as a set of C header files) usually constrains the choice of implementation language.

However, I contend that designers of educational software should make their choice of implementation language from a broader perspective, and consider using one of the many object-oriented programming languages. One reason for believing this is that the much touted advantages of the object-oriented approach - code re-use and modularity - are finally bearing fruit with the advent of component architectures such as OLE/ActiveX, OpenDoc, and Java. This is a current industry trend that offers educational software designers a possible solution to a flaw which has dogged their efforts in the past. Jeremy Roschelle notes that "Available software for math and science, while often excellent within its own frame of reference, is failing to meet larger scale needs for re-use of interactive content. Software is too expensive, fragmentary, and incompatible to achieve broad marketplace acceptance. Instead of broadly useful "learning works," we have isolated lesson supports, each with its own idiosyncratic support of capabilities like graphing, communication, assessment, etc." [Roschelle & Kaput 95] This thought is echoed by Neilson and Thomas who stress that "avoidance of the inefficiencies of traditional courseware production is possible only if courseware production is viewed as the creation of reusable resources which address the core subject matter of a domain yet remain sufficiently flexible to permit tailoring to a particular lecturer's teaching style."[Neilson & Thomas 96]

There is no shortage of object-oriented technology on the popular computing platforms. There are several interesting object-oriented languages that have not hit the mainstream, such as Self [Ungar & Smith 96], Eiffel [Meyer 88], Dylan [Apple Computer 92], Beta [Madsen et al 93], and Object Logo [Paradigm Software Inc. 90]. However, the established object-oriented languages, with mature and stable development environments, include C++ [Ellis & Stroustrup 90], SmallTalk [Goldberg & Robson 83], Common Lisp Object System (CLOS) [Keene 89], and now, Java [Jackson & McClellan 96].

1.3 Java

Java is a general purpose programming language with features which make it 'platform independent': that is, programs written in Java run without regard to the kind of computer being used. Java supports object-oriented programming and contains special objects that increase its utility as a platform for distributed computing. Specifically, these objects make it easier to build programs which pass data between different computers on a local or wide area network. Java is a compiled language rather than one which is interpreted line-by-line. More accurately, Java is compiled into machine independent 'byte codes' which are then interpreted at run time by a software 'virtual machine'. The virtual machine must be implemented for each platform Java is to run on.

Java's variety of object-orientedness is based on classes rather than prototypes. This means that the programmer must first define all the methods and variables of a class and then proceed to create instances of the class to form the objects which do the work of a program. This class-based approach can be contrasted with that of prototype-based languages, such as Self, in which objects can be defined and instantiated in one pass. It has been argued [Drescher 87] that the prototype-based approach is equivalent in expressive power, and much easier for programmers to learn, than the class-based paradigm. It has also been pointed out that class-based languages lead to inflexible code which is less readily adapted to a new purpose or context [Stein et al xx]. On the other hand, proponents of class-based languages claim that the methodology encourages preferred software engineering practices such as top-down planning.

There is less equivocation with regard to Java's support for inheritance, the mechanism by which a class descended from a parent superclass inherits methods and variables. Specifically, Java only weakly supports multiple inheritance; classes can inherit directly from only one parent, plus they may (in Java terms) implement an interface to one other class and gain access to methods and variables defined therein. This might seem to be an esoteric point, but multiple inheritance is used to strong effect in several class libraries (such as MetroWerks'

PowerPlant [MetroWerks 96]) where it allows for more compact and flexible code. Java's low level of support for multiple inheritance has attracted some criticism.

Java supports multi-processing through threads, which are objects to which the system apportions regular slices of processor time. When given the central processor's attention a thread executes its run method, into which the programmer can place relevant instructions. Threads are useful, especially so given the asynchronous nature of today's event-driven and Internet connected systems, and they are relatively easy to program. A common situation where threads find a use is in the downloading of text and graphics to a Web browser. The text and graphics of a Web page are stored in separate files on the server and quite often the graphics files are much larger then the text. The channels through which the two datatypes move to the user's browser are typically powered by separate threads, each moving at their own pace. A third thread is polling for user input and driving the browser's interface, which means the user can scroll the Web page, and click on URLs, without having to wait for the graphics to finish downloading.

The built in functionality of Java can easily be extended with libraries written in Java itself, or (with a little more difficulty), any other language. Libraries can be loaded dynamically, at run-time, even over a network. However, at present there is no provision for unloading a library, which makes it possible to carry on filling up memory, but this is expected to change in future.

One of the libraries that Java comes with as standard is the Abstract Window Toolkit, or AWT. This allows programmers to construct graphical user interfaces which will have a similar appearance across all the platforms that support Java. The AWT though, is lacking in many of the interface elements and widgets that designers for the MacOS, or Windows, or Motif, are accustomed to using in their software.

Java's support for media is a mixed bag: Java knows about text and a few fonts and styles, but not to the level programmers of other platforms are used to. Java currently can handle just one kind of audio file, a low quality format proprietary to Sun Microsystems Inc. Java can access static image data stored in GIF and JPEG formats but has no support at present for moving images such as Quicktime or MPEG movies. However, media support is certainly an area where Java will be improved in future releases.

Finally, Java does not possess any introspective features. That is, Java programs can't easily treat other Java programs as data, and can't create, manipulate and execute pieces of Java code on the fly. Programmers used only to C, C++ or other static languages will not miss this capability. But Lisp programmers, who are used to creating parsers and lightweight language interpreters in just a few lines of code, will bemoan Java's shortcomings. In mitigation, Java's defenders can point to the compactness of Java code.

With this rather large list of concerns in mind I now move on to describe an existing educational simulation which I have partially re-implemented in Java.

2 Gravitas

2.1 Gravitas in Object Logo

Gravitas [Sellman 92] is a dynamic simulation which offers the user the experience of working with mutually gravitating objects in a 2-d space. Users can easily build their own Solar System, or asteroid belt, or shuttle launch, and observe the time evolution of the system. Gravitas calculates all the forces between the gravitating objects and animates them smoothly across the screen. Users can alter initial conditions, and they may vary parameters during the simulation using a Direct Manipulation [Shneiderman 83] style interface.

Furthermore, Gravitas is fully user-scriptable via a simple programming language. This scriptability leads to some novel patterns of use, such as multi-stage rocket journeys between orbiting bodies [Sellman, 94, ch. 3] and the observation of solar systems with evaporating central stars. Even very simple scripts (less than 10 lines of Logo) can usefully expand Gravitas' capabilities, for example by providing a function which measures the kinetic and potential energy of a system. Figure 1 shows a version of Gravitas written in Object Logo [Paradigm Software Inc. 90], a powerful dialect of Logo for Macintosh computers. The figure shows four imaginary celestial bodies heading for a collision. The trails of the moving bodies are just visible, and the control panel at left displays the relevant physical parameters.

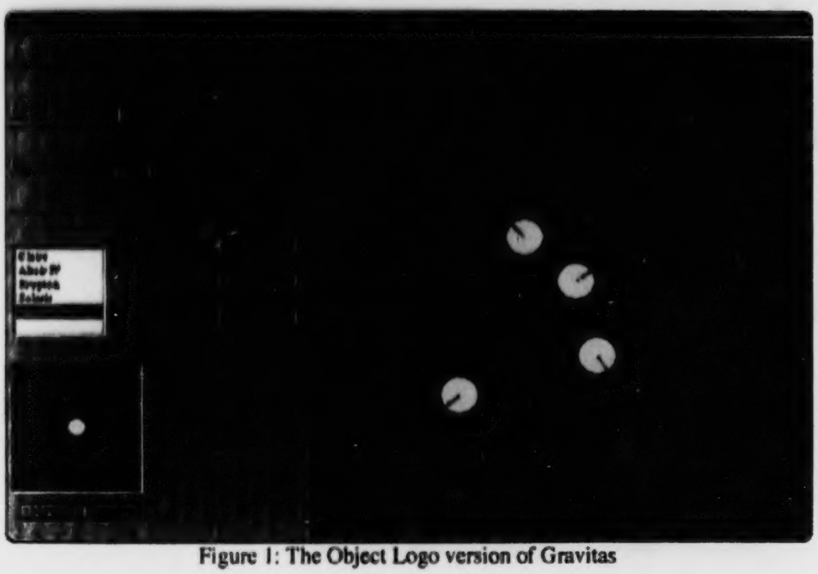

Figure 1: The Object Logo version of Gravitas

Studies with real users indicate that Gravitas offers new ways of learning physical concepts such as gravitational force, momentum, conservation laws and orbital mechanics. Writing this version of Gravitas in Object Logo demonstrated the efficacy of the dynamic, object-oriented approach to constructing such systems: the Object Logo version was built in a much shorter time than a subsequent implementation in C. The simulated celestial bodies, and the other components of Gravitas, such as viewers, gauges and buttons, are implemented as first class objects, in the sense that they have their own private data and methods for generating behavior and appearance. Many of the Logo objects underlying the interface components have been re-used in other programs.

2.2 Gravitas in Java

Figure 2 shows the re-implementation of Gravitas in Java.See also http://www.shef.ac.uk/~pc1rfs/gravitas.html

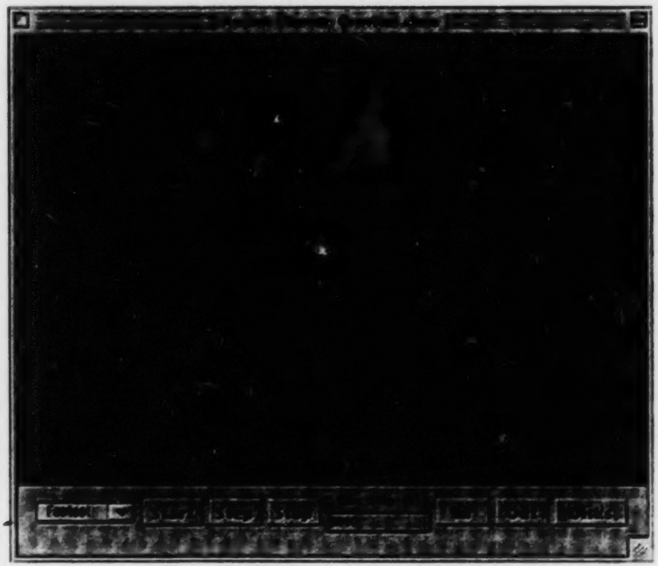

Figure 2. The Java version of Gravitas

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The Java version (implemented here as a Java applet) is missing many of the features of the original Gravitas; most significantly it is not scriptable by the user. Of course, this can be fixed in future, given time, but our main purpose here is to highlight those Java features of general interest to educational simulation designers that the new implementation exposed. Some of these features are visible on the screen, others are no less important but are hidden in the Java code. I describe a selection below.

Interface items:

The figure shows a system containing four celestial bodies representing the planet Jupiter and three of its moons. These bodies are displayed in a viewer representing a region of space. The viewer can be panned and zoomed to view objects which have travelled out of range. The objects can be dragged into position in the viewer with the mouse to allow the investigation of arbitrary configurations. Dragging with the mouse requires some way of recognising that the mouse is over an object and although Java only offers built in support for hit-testing of rectangular graphical objects, it was not difficult to implement a custom algorithm which detects mouse events inside the diameter of a planet or on its label.

For the dragging just described and for driving the simulation I implemented a smooth, flicker-free animation engine. Java supports this by allowing the programmer to compose complex graphical images in off-screen buffers called images. The contents of an image can then be drawn to the screen without flicker by using an efficient rectangular area copy method. Java's image objects are used in a second context also: the celestial objects have a 3-d appearance, as if they were illuminated from above and left (something of a paradox as the objects only move in two dimensions; however, this allows for future expansion). The shaded appearance is computed by a standard algorithm just after the object's viewer size is calculated, and then stored into an offscreen image which is drawn into the viewer, when required, by the same efficient copy method.

Several common interface widgets are visible in the figure: menus, labels, buttons and gauges. Each of these objects is a descendant of the Java Abstract Window Toolkit component class. This means they each receive events from the system and have their own methods for handling them and can therefore work in new contexts. Java has a built in button object which covers most uses, but Gravitas required some special behaviour - a button which acts for as long as it is pressed, for instance - so I developed a custom button class which has its own methods to generate appearance and behaviour. Getting custom components such as these to communicate with the rest of the program is particularly straightforward in Java. The custom buttons simply send event objects to the applet's event handler method which can then take the appropriate action. No other internal 'wiring' is necessary. Several C++ application frameworks could learn a lesson here (eg. [Metrowerks 96]).

Underlying objects:

The celestial bodies are a implemented as an independent Java class with its own private variables and methods. The variables, representing mass, position, velocity and so on, are manipulated through the use of setter and accessor methods. This is standard object-oriented programming practice, and it ensures that changes to an underlying representation do not have repercussions throughout the program as a whole. Java encourages this kind of structure but does not actively support it by, say, automatically creating setter and accessor methods for each class variable. Instances of the celestial object class store the positions and velocities in high precision floating point variables (Java doubles) to reduce errors. They also store the precomputed shaded images mentioned above.

The Java implemented celestial objects do not have a method for drawing themselves. Instead, viewers do all the drawing and maintain a list of depictable objects together with a method for drawing each type of depictable object. This separation of object and depiction will in future allow the addition of different kinds of depiction method, such as one which looks like a spacecraft, or one which looks like the real Jupiter. Of course, programmers are able to separate functions in this way in conventional languages too, but it requires some ingenuity in say, C, whereas in Java it seems natural.

The mathematical engine, which computes the forces between each pair of bodies in the viewer, is implemented in a separate Java thread object. This thread is serviced regularly by Java (every millisecond or thereabouts) and so it had to be implemented in a very fine grain way to avoid locking out the thread servicing the interface. If there are n objects in the viewer, then to take account of every gravitational interaction in the system, n2 calculations have to be made during each step. If these were all done in one go then the interface thread would receive little of the processor's attention and the user would be faced with a very sluggish applet interface. So it is arranged for just one interaction to be computed at a time, and the screen is only updated when a whole set of calculations is finished. In a more advanced multi-tasking system this responsibility would be taken out of the programmer's hands and left to the operating system (as it is in Unix for example), but Java, being platform independent, can not make the assumption that this feature is present.

2.3 Comparison of Java and other implementations

Compared to other implementations of Gravitas the Java version's major deficiency is lack of end user scriptability. It would certainly be possible to build an interpreter in Java for a suitable scripting language, but it would require a much greater effort than the same task in Lisp or Logo, where the introspective features mentioned above (in section 1.3) give the programmer access to the underlying interpreter. In this area, Java is a loser.

Another weak area of Java is performance. On a PowerPC, the mathematical engine runs about one tenth as fast as an almost identical engine written in C++, and it is less than half as fast as the Object Logo engine, which is also working to slightly higher precision (although this is of little importance). However, not too much should be made of these figures as they are very rough, they do not take account of improvements which can be obtained with the use of so-called Just In Time Compilers, and the underlying Java system has still some way to go before it is fully optimised for the PowerPC. Furthermore, programmers can escape from Java performance bottlenecks by writing 'native methods' - code written for a specific platform and imported dynamically by Java at run-time. The cost of this technique is of course a loss of portability.

At several points in the development of Java Gravitas the Abstract Window Toolkit's lack of support for irregular shaped screen regions was found to be a nuisance. MacOS and Windows programmers are used to these constructs, which make it easier to do proper hit-testing and flicker free screen updates. Although a workaround was developed here, it is far less efficient than the real thing. Fixing this shortcoming will require an overhaul of Java's Abstract Window Toolkit.

Java's much vaunted removal of the burden of memory managment from the programmer proved to be partly a mirage. It is true that the really low-level tasks (allocation and deallocation of blocks of memory for data structures) are gone, but it is still possible for the careless programmer to create invalid (or null) pointers, which halt the Java interpreter (much less serious than crashing the computer) and have to be debugged. Also, wise programmers keep track of how many objects they are creating as this process carries some overhead and can lead to sluggish performance.

3 Conspicuous Advantages of Java

Without doubt, it is exciting (to a programmer at least) to build a Java applet like Gravitas, install it on a Web server, and then tour around an assortment of Internet connected computers (perhaps, if budget allows, in foreign countries) and see it running. However, there are less frivolous advantages. If we ignore the question of charging for the use of applets (a topic beyond the scope of this paper), then the problem of distribution, which is especially acute for educational software, since there is little commercial support, is drastically reduced.

Summarizing the barriers to the portability of electronic learning resources (in the pre-Java era) Collis & De Diana set out four categories of obstacle: a) technical factors; b) educational factors; c) social/cultural factors, and d) organisational factors [Collis & De Diana 94]. While not a panacea, it is clear that Java can have a strong impact on categories a) and d).

Turning the process around, Java also gives applets a window on the wider world of the Internet, making it more straightforward to 'plunder' online resources. Although Gravitas does not support it currently, I have begun work on a Java program to extract data from online astronomical tables such as http://www.navcen.uscg.mil/gps and use it to automatically generate orbital systems in Gravitas.

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Going a step further, if enough people build good quality educational applets, which can be tailored to individual teaching styles (here the scriptability discussed above can play an important role [Sellman 94, ch. 4]) then perhaps the Internet can be the vehicle for an 'educational SuperInterface' [De Diana & White 94], to 'support large scale telestudy' and augment current distance education practices.

4 Summary

So how does Java come through this examination? The major drawback from the point of view of Gravitas is the amount of extra work that would be needed to achieve scriptability. And, as I have contended above, far from being an esoteric requirement, scriptability is one key to providing flexible educational simulations. Still, this issue is not a showstopper, merely a hurdle.

Java's outright performance is still inadequate for many situations. It is not unusual for educational models to use algorithms whose time performance for a number of objects n is O(n2) or worse, and Java has a high price in such situations. New Java technology will close the gap with traditional languages such as C++, but when or even whether it will truly catch up remains to be seen.

Java has a reduced set of user interface components or 'widgets' compared to those a designer working with the MacOS, or a Windows variant, or a Unix graphical interface toolkit, is used to. But educational software seems to have coped with relatively unsophisticated (but not badly designed) interfaces, so perhaps this is not such a serious drawback.

Gravitas does not make much use of multimedia datatypes and so Java's weakness in this area was not a hindrance to development. However, it could be a serious obstacle for an application that relies heavily on sound or video. Undoubtedly, there are strong commercial pressures for Java to improve its support in this area, and assuming this leads to an extended Java standard, rather than piecemeal solutions, then educational software will be able to reap the benefit.

File handling is another area Java Gravitas does not exploit. In fact file handling is problematic for Java applets, because security restrictions mean applets cannot open files on the local system of the browser they are running on. They can, however, create and manipulate files on their server, which is adequate for some uses.

Above all, Java is a fast moving technology with a lot of development momentum behind it. A new version, Java 1.1 is expected in early 1997. There is a good chance that the obvious flaws will be hammered out. For educational simulations at least, Java represents a great opportunity. A Saviour perhaps, and certainly no Saboteur.

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Designing a Web Browser for Children

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Abstract: The World Wide Web is a wonderful resource for children. It can be used to educate, excite and entertain. Until very recently there have been no Web browsers designed explicitly for children. In this paper we look at some preliminary design decisions for a children's browser, including a simple text to speech tool, graphical previews of pages before the link is selected, graphical history lists, and themes. We provide ways to interact with web pages as well as look at them and select links.

Introduction

Children have been using the World Wide Web for several years now. There are thousands of sites which are designed specifically for children to access. A few of the better known ones are *Yahooligans*, *Kids connection*, *Kidscom* and *Kids space*[1]. Some of these, the best known probably being *Yahooligans*, include databases for children to search to find items of interest. These databases have been constructed to contain references to information useful or appropriate for children, rather than being general purpose Web databases.

A vast amount of work is put into these child centred sites. The interesting thing is that until very recently [ConnectSoft] no one has designed a Web browser specifically for children, or allowed the major browsers to be customised enough to give them more *pleasure-of-use* [Oostholt et al. 96] for children. This paper presents the design of a browser for children which helps the user move around the Web without relying on text. The interface to the browser is designed with children's interests in mind. It also encourages children to customise the browser and modify and interact with the material it presents from the Web.

We look at some of the things which are wrong with current browsers if they are to be used by young children and describe some of the solutions we are trying in our browser, known as *Scooter*.

Current Browsers and Text

There are several ways in which current browsers can be improved to make them better for children. The first is by cutting down the reliance on text. Much of the content of the Web, not in the number of bytes transmitted but in the amount of screen real estate which is used to display it, is text - even on sites designed for children. This is understandable given that HTML (HyperText Markup Language) originally concentrated on ways of presenting text. Text is compact, easy to transmit and generally carries the sort of information educated adults are most familiar with.

Many of the children's sites are designed for children in the age range from eight to twelve, which covers a very broad range of reading ability. Many authors of these sites assume that only children able to read and comprehend text will use them. Sites which are designed for younger children frequently employ less text, and the text which is provided may be intended for adults or older children to read to, or along with, the younger child.

The links on these sites are sometimes text only; others include graphic buttons as links. Unfortunately it is frequently difficult to make out what connection the graphic has to the linked page. The text usually contains more information.

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[1] See [Resources] for URLs.

Text also monopolises in other areas where a more graphical approach would be useful, this time in the browsers themselves. The history lists which browsers maintain are either the titles of the recent pages or in the worst case the URLs (Uniform Resource Locators) of recent pages. Similarly the bookmarks which users maintain to keep track of pages they want to return to are always textual. The browsers' menus and dialogue boxes suffer from the same limitation.

These resources are thus impossible for non-readers to use, and difficult for beginning readers[1].

The Children's Browser and Text

As we have seen, not only is much of the content of many Web sites provided as text, the history and bookmark lists are also stored as text. Many of the links are only provided as text.

In order to open-up use of our browser to beginning or non readers one of our key decisions is that it should be possible to translate all text on the screen into speech by the browser. We are investigating the use of technology such as that provided by Apple's *Plain Talk* [Apple Computer, Inc 95]. *Scooter* has a speech balloon or talk tool [Fig. 1] which can be clicked to read all the visible text on the current page. If a child wants to read a specific block of text, that text can be dragged to the talk tool button. The print tool button functions analogously: clicking the print tool button prints the whole page; dragging a picture or a section of text to the print tool causes the picture or text to be printed.

The title of the page is spoken as soon as the page is displayed. Highlighting of the text as it is read is used to help the children make the connection between text and words. *Scooter* does not have text associated with its tool buttons. If the child holds the mouse pointer over a tool button for more than a second it causes a brief description or name to be spoken, e.g. "I am the talk tool, drag words to me and I will read them to you".

Whenever a question needs answering via a dialogue box *Scooter* automatically reads the question and the possible replies are read in turn and when the pointer hovers over them.

Links

We also have a secondary attack on the problem of text. After displaying a page *Scooter* also downloads each page pointed to via a link from that page. The pages aren't shown automatically, but are stored to display a preview to the user. This is similar to the method used in the WebBook [Card et al. 96] system, except in that case a book of related pages is constructed. When the user moves the pointer over a link and holds it there for a second a preview of what that page looks like is displayed. This preview is displayed directly over the link's position on the display. A click on the preview activates the link.

One difficulty with this is the time required to download all the pages and generate the previews. Not only does the page have to be accessed but any graphics (ignoring animations for the time being) have to be downloaded. The graphics are essential because the preview is supposed to give the user a good idea of what the page looks like if it is selected.

To solve the problem of slow connections we suggest adding a page preview capacity to pages which are likely to be accessed by children. A page preview graphic is pointed at via a <META> tag, including the string "preview" in the name field and the URL corresponding to the preview in the content field. As in

<META name = "preview" content = "http://www....">.

Our recommendation is that the preview graphic shows what the top of the page would look like in a browser window filling a screen of 640x400 pixels. The preview itself should be reduced to a graphic of 160x100 pixels, to speed transport and allow suitable display. Partly because of these specifications *Scooter* needs a screen of at least 800x600 pixels.

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[1] We have observed that the frustration of not being able to read text on a computer screen has helped provide the motivation for some children to work harder on their reading.

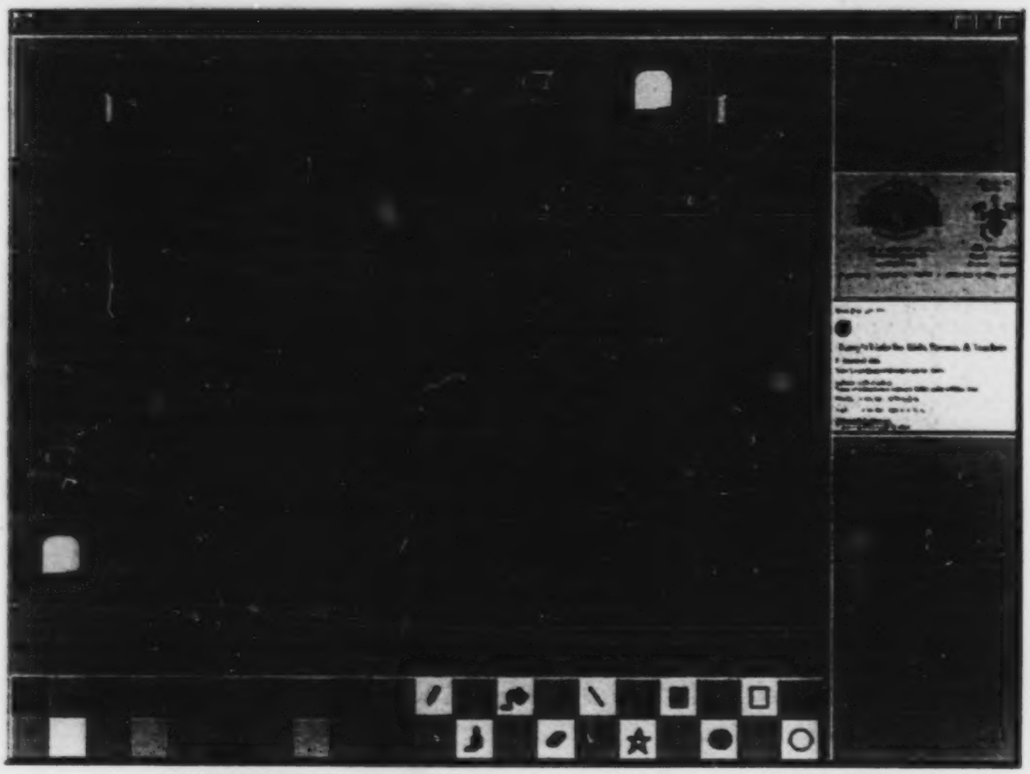

Figure 1: Screen shot of Scooter, showing the drawing tools and history list.

After downloading a page, the browser starts contacting each potential link site and determining whether or not a preview graphic is held. If it is the preview is downloaded, ready to be displayed when the user moves over the link, otherwise the whole page is preloaded and the preview is generated by the browser. This can be turned off if necessary, restricting previews to those pages which are cached.

Authors including page previews of their pages should adhere to some simple recommendations:

- If the page includes frames, the frames should be ignored in the preview to cut down the clutter and leave more space for the focus of the page.
- The main section of the page should be the previewed area.
- One or two medium sized graphics are more useful than lots of little ones.

An aside: We suggest that the best pages from a child's point of view are those that retain their visual interest even when reduced to 1/16th of the intended size.

An added side effect of fetching these previews is that the browser can determine links which are no longer valid or have been moved before the user selects the link.

It should be clear that we are not intending such a strategy to be used on pages which do have a very large number of links. In Web pages designed for children we see no justification for long pages with lots of links. Even sites which provide large useful indexes should be broken down into related areas. So to all authors of pages for children we add further recommendations:

- Keep the number of links on a page down to a small number (less then ten, excluding forwards, backwards, and escape links).
- Design the page so that it can show the most important information in a window of 640x400 pixels.
- The whole page should take up no more than three 640x400 displays.

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History Lists

Scooter also stores these previews in the history list [see Fig. 1]. Of course the previews may be out of date, since the page they refer to has changed. The preview graphics are updated whenever the page is visited. The history list is shown in a separate section of the window. At the moment the history list uses full 16th size previews. We may shrink them down further to accommodate more pages. Holding the mouse pointer over a history list item causes the title of the page to be spoken.

Bookmarks and Treasure Chests

Lists of favourite sites, or bookmarks, are also augmented with previews of the contents of the sites. In the same way that current browsers allow users to type in any name they want to remember the page by, *Scooter* allows spoken or pictorial names. Pictures produced by users can replace the previews if desired. If a spoken name has been given, holding the pointer over the textual or pictorial name causes the child's recorded name to be replayed. Otherwise the standard textual name is spoken.

The bookmarks themselves are actually stored in a treasure chest. This is a multipurpose container for any objects the user wishes to keep.

Since a page preview of the current page is automatically placed in the pictorial history list when the page is displayed it is easy for a user to add the current page to the treasure chest by dragging the preview from the history list into the treasure chest. A dialogue box asks if the user wants to give the page a name.

Toolbar Buttons and Customisation

Apart from adding the talk tool we have reduced the number of buttons which appear in the toolbar, compared to currently popular browsers. This is both to simplify the use of the browser and allow more screen space to each button. Small buttons are difficult for small children to hit correctly. Currently our toolbar has forward and backwards buttons, home, treasure chest, find, print, and speak.

Something children really like doing is customising their belongings. One of the features of *Scooter* is the ability to select a theme for the buttons and the general appearance of the browser. For example the *Creepy* theme has a haunted house for home and skeleton hands for forwards and backwards.

Doing More with the Content

Current browsers do provide the ability to work with the content downloaded from the Web, but in very limited ways. The page itself can be saved (usually this loses any graphics associated with the page because the links are relative and the graphics are cached with their original addresses). Text or graphics can be copied from the browser window and then pasted into another application for manipulation. Sometimes graphics and links can be dragged onto the desktop, where they take on a completely different appearance, usually the icon associated with URLs.

If users want to do something with the text, graphics, sound or video clips, they must open up other applications, separate from the browser to work with them. This adds an extra level of complexity in dealing with the Web material. It is very common for children when they first start to use computers to say "Why can't I do that here? I could yesterday". The problem is that the child, understandably, cannot see why there is a distinction between different programs, and just because the same object appears in two programs, doesn't mean that the tools from both programs can be applied to it[1]. A particularly good child related example is to do with colouring pictures. Several children's Web sites provide black outline gif images which users are supposed to print out and colour in. Why not provide a colouring set (and other painting tools) within the browser itself?

This is what we have done with *Scooter*. And until we completely break down the user interface barriers which exist between programs we need to add further abilities to our browser to do *natural* things with the content.

We still have to determine the list of things which a child could reasonably expect to be possible. Currently simple drawing tools are provided to allow the user to make additions to graphics or design their own buttons, or draw representations of pages for the bookmark list.

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[1] This raises lots of further questions which are much broader than making a better browser

We are left with the question of what to do with pages once they have been altered. At the moment the changes are only maintained during the current session. We are investigating saving the changes as annotations to cached copies of the original page. This approach means that the changes will only be visible to other people using *Scooter*. There are several other approaches we are also investigating, which will allow such altered pages to be visible on other browsers.

The treasure chest, mentioned above, is designed to accept all Web page elements: text, graphics, video, and audio. Dragging and dropping graphical, and other, elements to the treasure chest is intuitive and very visual. The page element itself, rather than an unrelated icon, moves into the treasure chest, leaving a copy behind. At the moment the treasure chest is an unorganised conglomeration (a bit like a child's room). We need to investigate automatic ways of sorting the material, always giving the user the final choice.

Where to Now

The first version of *Scooter* is written in Java and apart from the talking aspect is designed to be platform independent. At the moment the talking *Scooter* is restricted to the Macintosh until we find a platform independent text to speech translator.

We still need to test most of the recommendations to see how much they contribute to making the browser more useful and pleasurable for children. And we still have several unsolved user interface problems, some of which are mentioned above.

Resources

Yahooligans http://www.yahooligans.com
Kids connection http://www.kidsconnection.com
Kidscom http://www.kidscom.com
Kids space http://plaza.interport.net/kids_space

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Multimedia Courseware for Teachers: Providing Flexible Professional Development

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Abstract
This paper discusses the rationale behind the development of an interactive multimedia CD-ROM which focuses on the use of new media in classrooms. The Multimedia and Information Technology Across the Curriculum (MITAC) CD-ROM is designed to provide opportunities for teachers to develop their own models of best practice using interactive technology across the curriculum. Through peer mentoring, ongoing support and a flexible schedule which provides adequate time to practice and implement new learning strategies, teachers are able to meet their professional development needs in a new and rapidly changing area.

Introduction

The influx of computer technology, and instruction with and about computers, has been a key theme in education over the last decade. Over this period, the number of computers in Australian schools has increased dramatically, as has the level of knowledge and expertise required of teachers to effectively integrate computer technology into the curriculum.

It has been acknowledged that in strongly urging (often requiring) teachers to use information technology (IT), especially computers, as an integral part of their teaching, they are being asked to undertake a considerable amount of personal learning. Such learning is not only with respect to working with a new technology, but in full consideration of its impact on the curriculum and change in curriculum practice. If the potential of computer technology is to be exploited fully, new teaching styles have to be developed to support new modes of learning. Consequently, the traditional role of the teacher requires critical review, particularly when teachers themselves select the technology options most appropriate to content-learning tasks. In whatever way schools may change in the future, it is how teachers view technology and their preparation to use IT to instruct, manage and evaluate which is critical to the effective integration of IT into the curriculum.

Professional Development

There are very few opportunities for teachers to engage in learning activities to assist them in becoming competent and confident users of the new technologies. Teachers are not always able to attend inservice activities or university courses, which may be timetabled at inconvenient times, nor do they necessarily have the confidence or knowledge to explore technological options in their own time, even if they do have the requisite hardware and software. Where IT has been used in school programs it has usually been introduced by enthusiastic individuals with particular expertise and interest in the area.

In addition, research has shown that traditional face-to-face inservice approaches do not always result in a long-term change in practice [Wilson 1990] [Zammit 1992] [Sherwood and Buchanan 1993]. Many educators who complete an IT-related professional development activity are initially enthused and committed to the implementation of the technology into their classroom. However, this initial enthusiasm wanes quickly (unless appropriate on-going support is provided) as the reality is that few teachers get the time to experiment, learn and practice integrating new technologies into their classrooms.

Teachers are the ultimate gatekeepers in classrooms. Therefore, it is critical that teachers *are* provided with the skills and confidence to explore technological options for their classrooms and schools with the clear intention of enhancing student learning both about and through information technology. Enabling teachers to become proficient, critical users of IT, involving them in IT planning and diminishing their physical remoteness and/or sense of isolation, requires a high level of commitment and involvement from all education stakeholders including education authorities and universities.

Developing a Multimedia Professional Development Resource for Teachers

In Queensland, in the last five years particularly, there have been a number of collaborative activities between teacher education stakeholders designed to meet the professional development needs of teachers in IT. During this period, the move by Australian universities into more flexible approaches to delivering education has coincided with an initiative of the Commonwealth Department of Employment, Education, Training and Youth Affairs (DEETYA).

From 1994-1996, DEETYA provided funding under a National Professional Development Program (NPDP) to provide resources to assist teachers in the renewal and extension of their teaching and to help them to improve work organisation and teaching practices within their schools. An important focus of the NPDP was "to provide teachers with the opportunity to play a central role in determining their own professional development needs within the context of emerging national priorities and the goals for Australian schools" [Department of Employment, Education, Training and Youth Affairs 1996]. Professional development activities were designed to assist in the renewal of teachers' discipline knowledge and teaching skills and in helping teachers to improve work organisation, practices and teaching competencies within schools. A second key feature of the NPDP was that it encouraged and supported partnerships between universities, education authorities, teacher organisations and schools.

The increase in the number of interactive multimedia (IMM) applications available for use by schools and the interest shown by many teachers in multimedia as a development tool for themselves and their students led staff at two of Queensland's universities (Griffith University and The University of Queensland) to apply for, and receive, NPDP funding in 1995 to redesign a Graduate Certificate in Computer Education (Multimedia).

While the two universities offered a number of subjects with a focus on the integration of IT into classrooms, neither offered a suite of subjects that:

- could meet the professional development needs of teachers in a new and rapidly changing area
- provided an inservice model which had relevance to the teachers' own curriculum
- enabled teachers to be mentored by their peers
- provided adequate time for teachers to practice and implement new learning strategies, and
- provided ongoing support as well as recognition for teachers' efforts.

An advisory group to assist the project directors was established at the outset of the project. Members of this Project Reference Group were representatives of national and state teacher professional associations in all eight Key Learning Areas together with representatives of primary and special groups.

The outcome of the NPDP grant is the Multimedia and Information Technology Across the Curriculum (MITAC) CD-ROM which has been jointly developed by the two universities in cooperation with the Queensland Department of Education, and enables teachers to gain an understanding of information technology (with a focus on multimedia) and how it can be integrated into classrooms.

The broad client base targeted by the MITAC CD-ROM is that of educators in general. Traditional courses in this area depend on student attendance on-site or a long term commitment to enrolment in a course of study. These options are not suitable for many educators who have work, study or family commitments. The CD-ROM medium in itself ensures a degree of portability and flexibility for teachers, as does its cross-platform application (Macintosh and Windows). MITAC can be used either on an individual's personal computer or in a classroom/laboratory setting, depending on the preferred method of learning. Additionally, the fact that individual modules of MITAC can be undertaken on an as needed basis, means that learning can be targeted and immediate.

The MITAC CD-ROM

The MITAC CD-ROM provides current, flexible and practical multimedia training for educators. It contains all content required for the Graduate Certificate of Computer Education (Multimedia) including text, software demonstrations, interviews, sound files, and videos as well as a number of case studies which demonstrate best practice. These include a range of practical examples showing how teachers incorporate interactive multimedia as part of the teaching/learning process.

Advantages

One of the most obvious advantages of the MITAC CD-ROM is that it allows the process of exploration to be controlled by the learner, and therefore facilitates exploration without imposing assumptions about the user's prior understandings or commitments. Teachers can work through the material in their own time and at their own pace. It also provides:

- activities which are based primarily on the needs and concerns which teachers themselves identify
- the opportunity for teachers to take responsibility for their own learning and construct their own knowledge
- for the expertise of the teacher to be acknowledged
- opportunities for collaborative and collegial activities so that professionals are joined in working partnerships
- engagement of teachers in critical reflection of their teaching practices
- opportunities to integrate theory and practice.

Structure

The four subjects in the Graduate Certificate of Computer Education (Multimedia) are:

- Interactive Technology in the Classroom
- Interaction and Educational Design for Multimedia
- Designing and Developing Multimedia Applications
- Independent Study (Multimedia Project)

These four subjects together address the complexity of classroom activities from the role and impact of IT on pedagogy, multimedia tools for learning, to management of resources and school organisation. Teachers can use MITAC either individually or in groups, in a classroom setting or at home, as a complete qualification or a modular approach to professional continuing education.

The structure of the Graduate Certificate (including modules) is as follows:

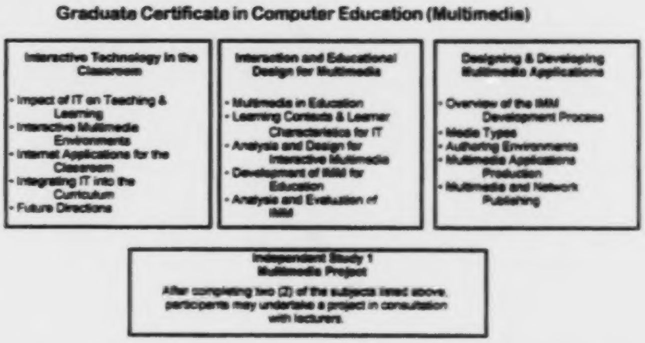
Graduate Certificate in Computer Education (Multimedia)
Interactive Technology in the Classroom
- Impact of IT on Teaching & Learning
- Interactive Multimedia Environments
- Internet Applications for the Classroom
- Integrating IT into the Curriculum
- Future Directions
Interaction and Educational Design for Multimedia
- Multimedia in Education
- Learning Contexts & Learner Characteristics for IT
- Analysis and Design for Interactive Multimedia
- Development of IMM for Education
- Analysis and Evaluation of IMM
Designing & Developing Multimedia Applications
- Overview of the IMM Development Process
- Media Types
- Authoring Environments
- Multimedia Applications Production
- Multimedia and Network Publishing
Independent Study 1
Multimedia Project
After completing two (2) of the subjects listed above, participants may undertake a project in consultation with lecturers.

Figure 1: Overview of the Graduate Certificate of Computer Education (Multimedia)

Each module is interactive and can be accessed in any order. For each subject, appropriate assessment items are outlined. Suggestions for self-assessment are provided for each module along with reflection activities. The fourth subject is a project involving the development of interactive multimedia courseware to support an instructional need in the teacher's own situation.

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By providing opportunities for teachers to select and develop their own content and learning processes, they are given opportunities to develop new kinds of pedagogies for use across the curriculum and to develop models of best practice using information technology.

Navigation and Content

One of the most important considerations in designing MITAC was to ensure that teachers with varying levels of IT expertise were able to use it competently. The framework is intended to give continuity of design and use throughout all the subjects that are contained on the CD-ROM. Once one subject has been completed, teachers are familiar with the layout and tools for all other subjects.

Entry to the material contained on the CD-ROM is via a 'campus map' which contains building icons for each of the four subjects along with an information booth. The map can be accessed from any screen.

Figure 2: Campus Map (Main Menu)

The **Information Booth** provides information about each of the subjects and other aspects of the CD-ROM.

The **Glossary** provides further explanation for terms used in the program.

The **Resource Centre** contains the readings which can be printed out, movies and animations, software demonstrations and audio files.

The **Assessment** building contains the assessment items required for each subject. It also contains the activities which must be undertaken by teachers if they wish to receive acknowledgment for professional development purposes.

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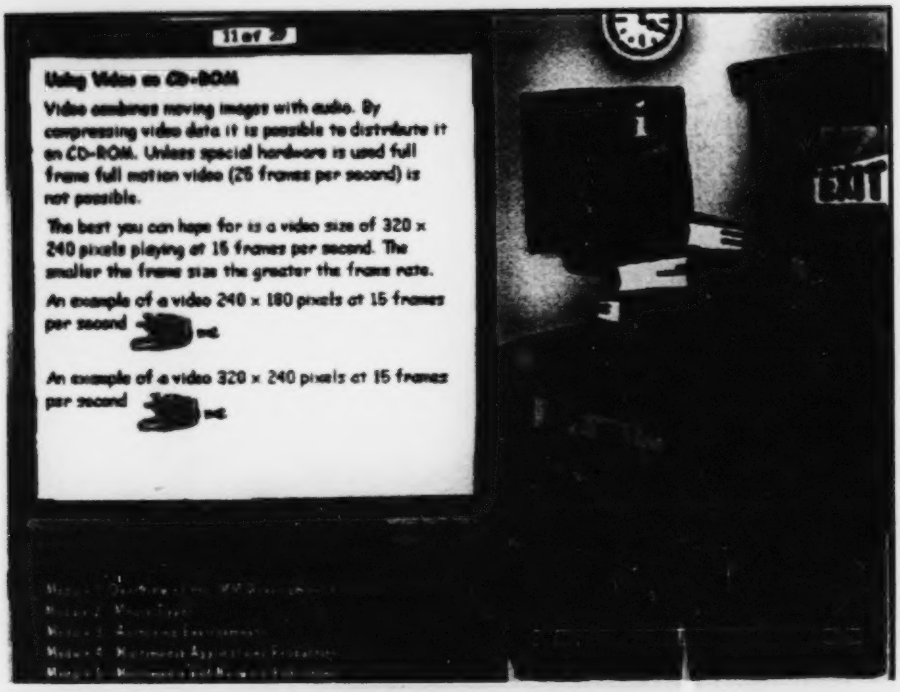

Using Video on CD-ROM

Video combines moving images with audio. By compressing video data it is possible to distribute it on CD-ROM. Unless special hardware is used full frame full motion video (25 frames per second) is not possible.

The best you can hope for is a video size of 320 × 240 pixels playing at 15 frames per second. The smaller the frame size the greater the frame rate.

An example of a video 240 × 180 pixels at 15 frames per second

An example of a video 320 × 240 pixels at 15 frames per second

Figure 3: Example of a screen in one subject

In each module there are buttons labelled *Show Me*, *Tell Me*, *Reading* and *Reflection*. *Show Me* usually brings up a QuickTime movie which can be, for example, a demonstration of a software package, an interview excerpt or an animated sequence. *Tell Me* provides additional information about terms, concepts and ideas used in the application. The *Reading* icon brings up articles from current journals or the World Wide Web. Selecting the *Reflection* icon will bring up screens with questions which prompt the user to consider issues as they apply to their own teaching situation.

Teachers have access to current sources of information about available software and can enhance their critical analysis skills to make judgments about its appropriate use in specific learning environments.

Trialing of Modules

One of the most important aspects of this project has been the involvement of teachers at all stages of design and development. Each member of the Project Reference Group nominated teachers considered to be either experienced in the use of IT in their classrooms or interested in its application. These teachers became the program evaluators and prototype testers. The teachers also provided case studies for possible inclusion in the program. Six program trials were conducted where teachers reviewed the content of the subjects, including related readings and other software resources provided by the project. The involvement of the teachers in this process was crucial as it provided excellent feedback on both the content and interface design of the program, for example, the identification of faults/errors, annoying or distracting sounds, and the modification of some structural elements. The helpful critique of the content meant that it could be made particularly applicable to the needs of classroom teachers. The teachers' overall assessment was one of approval and timeliness, and several indicated that they would like to have immediate access to the program to begin professional development with other members of staff in their school.

Accreditation Procedures

In order to qualify for the Graduate Certificate in Computer Education (Multimedia), teachers must complete and submit the assessment for all four subjects. For those not wishing to undertake the formal qualification, each of

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the modules can be accessed separately, either for individual professional development or through professional development offered by educational consultants, professional associations or by staff within a school or cluster. The Queensland education authorities (state, private and Catholic) provide a certificate of completion to teachers who integrate components of the courseware into their teaching and submit a copy of their work certified by their school Principal. These certificates can be used to support applications for promotion or to receive credit towards the Graduate Certificate in Computer Education (Multimedia).

Enhancing Professional Development

The development of MITAC is timely as the integration of multimedia, as a teaching/learning tool, into classrooms at all levels of education is now increasing. The content not only provides educators with an understanding of how new technologies can be used to support student learning and teacher effectiveness, but also demystifies the new information technologies. MITAC is therefore utilising technology to demonstrate the most appropriate models for its application as well as providing a flexible twofold approach to learning options.

As technology changes, so too will the content of the subjects. MITAC will be updated on a regular basis, not only to maintain parity with current technology but also to ensure that the content continues to meet the needs of teachers. This serves to enhance the professional development of teachers because MITAC models best practice through the integration of flexible learning strategies with content which is both current and relevant to the target audience. Educators are exposed to a working example of the way in which technology can be applied both now and in the future, as well as providing them with access to a resource which has the potential to be a powerful and unique support for their teaching endeavours.

Building Partnerships

This project would not have been possible without the development of closer links between teachers, employing authorities, professional associations, and tertiary institutions with the aim of providing ongoing support for teachers. The facilitation of collaborative and collegial relationships between classroom teachers and university personnel, and the utilisation of a resource such as MITAC provides the kinds of structures and cultures both organisational and occupational which are compatible with the image of 'teacher as intellectual' as opposed to the 'teacher as technician'. It is to be hoped that such a partnership will encourage the integration of technology into the classroom and the ownership of professional development by teachers as well as their participation in postgraduate study.

For further information about the MITAC CD-ROM, please contact the author.

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SINGING WITH SOFTWARE: THE USE OF COMPUTERS AND MUSIC IN EARLY CHILDHOOD VOCABULARY DEVELOPMENT

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Abstract: This study examined an interactive educational computer program containing instructional lessons set to the music of a children's song titled, *"Oh I Want to be a Dog"*. The five stanzas of the song were illustrated with animation and integrated with interactive educational modules. The purpose of this study was to examine the impact of a computer program that employs music in conjunction with interactive activities to teach vocabulary words to Kindergarten age students. The sample group for the pilot testing consisted of eight students from a large Southwestern Elementary school. Results from the study indicate that music and interactivity found in a computer program have the potential to enhance vocabulary learning for young children. Both groups tested reported to have enjoyed the program, however the group exposed to the music reported to have learned more vocabulary words than the non-music group participants.

The value of books, artistic exercises, song and play in early childhood education are well documented. Teachers have incorporated these "fun" and engaging pedagogical techniques into their curriculum for quite some time. More recently, the availability of affordable computers presents educators with an additional tool for early childhood instruction. Computer research suggests that through the employment of computer-aided instruction (CAI), children discover the vast learning activities generated by computers (Shade & Watson, 1987). Indeed, previous studies demonstrate the effectiveness of music in education (Medina, 1990) and computers (Escobedo, 1992; Clements & Nastasi, 1993); *few if any report the use of instruction and music delivered on a computer.* There is a deficiency of research examining the impact of these two variables in tandem on vocabulary acquisition. This project presents a first step in filling this void in the literature. To do so, this paper, 1) addresses the benefits of combining CAI and music and 2) examines, through the field test of a program, "Oh I Want to be a Dog" how CAI and music improves the instruction of vocabulary for Kindergarten age students.

Interactivity, Music and CAI

Educators have found the dissemination of information via visual and oral stimuli to be as a powerful educational device. Stimuli from the audio channel (music) combined with stimuli from visual channel (graphics) present opportunities for increased learning outcomes (Schramm, 1973). When music is presented on a computer as an "interactive song" it has the potential to: 1) enhance children's expression of ideas by allowing the students to draw and manipulate symbols that represent action in the song, 2) improve children's understanding of the relationships between visual images and words and between spoken and written language, 3) increase children's interplay with sounds, rhythm and meaning of words inherent in songs and 4) fortifies children with access to multisensory learning.

As instructional tools, both music and CAI share common elements such as interactivity (although with different applications) and contain opportunities for vocabulary learning when used effectively. However, there is a gap in the amount of research pertaining to music and computer aided interactivity as simultaneous events in CAI. The purpose of this study is to find out if the use of music and CAI will enhance vocabulary learning as a result of using the program, "Oh, I Want to be a Dog". Thus, the following questions are advanced:

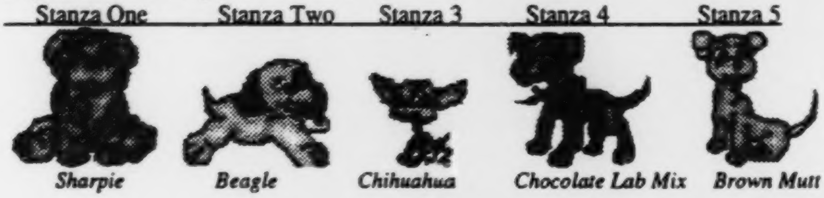
1. *How can the music and interactivity found in the computer program, "Oh I Want to be a Dog" enhance vocabulary learning for kindergarten children?*
2. *What are the student's perceptions and reactions toward the program?*

The Design of the Computer Program, "Oh I Want to be a Dog"

The song, *"Oh I Want to be a Dog"*, was written by Barry Louis Polisar. Charlotte Diamond, a popular Canadian children's performer, sings the lyrics. The composition of the song is divided into five stanzas and plays without a bridging chorus. Each stanza begins with the words, "Oh I want to be a dog" and continues to describe actions unique to that stanza. Among the actions are: a dog wagging its tail (stanza one) and a dog running after sticks (stanza four). The medium tempo of the song and the descriptive composition makes it easy for listeners to simulate the dog actions.

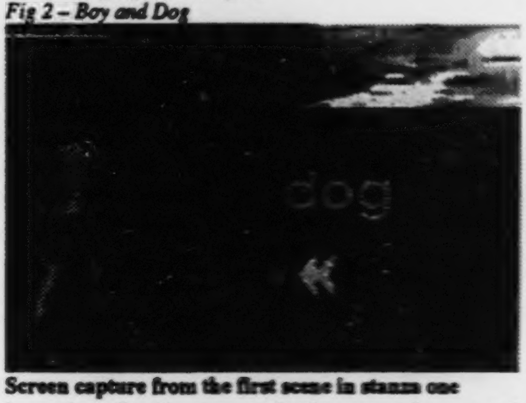
The *"Oh I Want to be a Dog"* program was created with the multimedia development software, Macromedia Director. Most of the graphics were drawn in Superpaint and imported into the program. The first screen seen gives the user a choice of either listening to the introduction, seeing the credits, clicking on the "dog check" dog which leads to the post-test section, or clicking on one of the five main character dogs. The five main character dogs are different for each stanza. They are, in order of the stanzas in which they appear (Fig.1).

(Fig 1) – Featured Dogs



When one of the dogs is clicked, the program opens to the stanza featuring that dog. Each of the five stanzas in the computer program contains three words chosen by the design team and author. These words are the "target" and are spelled out on screen during the music portion of the stanza. The target words are the specific vocabulary words for program users to learn. There are a total of fifteen target words for students to learn in the program. The format of each stanza remains consistent throughout the program, and yet the graphics and target words vary. Each stanza begins with lyrics "oh I want to be a dog," and describes the action taking place in that stanza. For example, as the word "dog" is sung, the word "dog" appears in textual form with an arrow pointing to the illustrated dog for identification purposes (Fig.2).

Fig 2 – Boy and Dog



Screen capture from the first scene in stanza one

Immediately after the music section of each stanza ends, the screen freezes and interactive buttons appear. At this point, students have the choice of either going to the interactive practice section, repeating the music portion, or going to the next music portion. The dog from the corresponding stanza is located in the middle of the screen while the target words form a semi-circle around the dog's head. When the student clicks on the word "dog", for example, the song lyrics, "oh I want to be a dog" are heard and the dog shakes its legs and head indicating that the word "dog" is part of the song and represents the animal on the screen. All five stanzas employ the equivalent format for the practice section, and display three target words chosen from the lyrics of the song.

Dog Check (Post-Test)

When students finished the last practice section, students were asked to play with the "Dog Check". The

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"dog check" is composed of the fifteen target words from the program, as well as their graphical representations. Each screen hosts three words from different stanzas and their corresponding graphics to make a total of five screens. The object of the exercise in the "dog check" section to use the mouse to drag a graphic from the right side of the screen to the word it represents which is located on the left side of the screen. For example, the second screen of the "dog check" displays the words "moon", "wag", and "dig" on the left side and their graphical counterparts on the right side of the screen. The word "moon" and the picture of the moon are taken from stanza four, the word "wag" and the dog wagging its tail are from stanza one and the word "dig" and the dog digging are from stanza two. The "dog check" was designed so that the five different dogs featured in the program are paired with the target word from the same stanza the participants were exposed to during the music and practice portion of the program. It was used as a measurement to access vocabulary acquisition.

Software Design Considerations

There are many considerations incorporated in software design. When designing *"Oh I Want to be a Dog"*, the production team considered factors such as music, age appropriateness and multichannel learning as important design features in an effective and enjoyable program. These design considerations are discussed below.

Music. Music played two major roles in the design considerations for the computer program, *"Oh I Want to be a Dog"*: as a visual/animation guide and as a catalyst for motivation and social interaction. As a visual guide, music plays an identical role to that of narration in a story. Just as a storybook narrative guides the artist in illustrative decisions, lyrics dictate visual design. Computer program animation illustrates the song's words. For example, the dogs behave according to the lyric description of them. Also, the length of the "chapter" or stanza solely depends upon the tempo of the music. The break point in the stanzas is a natural lead in for the practice sections.

When music is simple, clear and easy to understand, it is effective at motivating the student to sing and enjoy himself or herself (Beaty & Tucker, 1987). The program, *"Oh I Want to be a Dog"*, utilized music's potential to engage and excite the listener. Music encourages students to sing together, make up musical stories and it provides an activity that can be shared by many. Students not only work together at the computer making decisions, but the program also grants an opportunity for voices to join together in song. When students are familiar with the song, they sign along with the software.

Age Appropriateness. The issue of "suitable materials" is important when designing software. Beaty and Tucker (1987) explain that "a developmental toy, ... should be challenging but not too difficult for a child. Some puzzles are too simple, some too complex" (p. 48). In order for software to be effective, it must be appropriate for the age of the child. It must take into account reading ability and motor skill functions.

One of the challenges in designing computer programs for young children is that they are not advanced readers and are unable to follow written directions. In the case of pre-literate youth, it is sensible to use text plus graphics. *"Oh I Want to be a Dog"* uses this technique throughout the program. The target words displayed during the music portion and practice section are accompanied with graphics that correspond to the text. When the dog runs on screen in the first stanza, the word "dog" appears on screen with an arrow pointing the to picture of the dog. Although kindergarten students cannot fully read, they begin to make the connection between words and pictures.

Another challenge to designing computer programs for young children is they require activities which do not demand extensive typing or advanced motor skills. Research found that young students show the greatest efficiency with a computer mouse instead of the joystick, and keyboard (Alloway, 1994). Therefore, the program *"Oh I Want to be a Dog"* was designed utilizing the mouse so young children could easily and readily use the medium. The mouse is the only device for interactive control.

Children need to control actively what the program does (Beaty & Tucker, 1987). Users of the program, *"Oh I Want to be a Dog"* have many control options in the practice and "dog check" sections. The practice sections allow users to click on the words in any order and multiple times. The "dog check" section encourages students to decide which word they want to drag with the mouse first, and where it belongs on the screen. Navigation buttons are also a source learner control. Users make constant choices on where they would like to go next in the program. They have a choice of either going to the home page, repeating the music, going to the next stanza or reviewing the target words in the practice sections.

Multimodal Learning. Songs can be audio-visual (as evident with music videos) and kinesthetic in their heart-felt beat as well as emotionally stimulating. The combination of computer programs and music provides all three sensory domains to promote a better chance for multiassociational encoding of information. All three sensory domains are utilized in the computer program, *"Oh I Want to be a Dog"*. Users see the actions on screen, hear the accompanying music and sway their bodies to the beat. The triple repetition of the target words via sound, graphics and text increase opportunities to learn new vocabulary.

Procedure

The students were visited two times. The first visit was for observational purposes and allowed the experimenter to assess the student's knowledge and enthusiasm toward computers in general. The researcher remained in the classroom approximately one half-hour and watched as the students worked on computer programs available to them. Also, a consent form was sent home to the parents.

Eight students were selected to participate in the study based on consent form return, availability and gender. During the second visit, the researcher set-up the *"Oh I Want to be a Dog"* software and called the participants to the computer, one at a time, to work with the program. The program was not available to the students prior to the researchers second visit to the classroom, therefore the students were not familiar with the program content or the song.

Before each participant began, the researcher explained the testing procedures and directions for using the computer program. There was no time limit each student could work on the program, but the length of time per individual session was recorded. After the participants viewed the music sections and practiced with the words from each stanza, the researcher instructed the participants to return to the home page to access the computer-based post-test, or the "dog check". The researcher gave students instructions on how to interact with this section and then recorded their actions. This procedure was repeated with each student for a total of eight individual sessions.

The researcher recorded how many attempts it took students to connect each picture to the text it represents. The participant received a perfect score of fifteen if they matched all fifteen words and pictures on their first attempt. Five was the lowest score possible because of the screen layout. If students got two of the three words on screen identified properly, the student matched the third word to the correct graphic because it was the only remaining choice. The data generated from the post-test was based on the number of times it took the students to get the correct answer on their first attempt at matching the graphic with the textual equivalent.

The researcher also asked the participants six basic questions in random order, in regard to user reaction to the program: 1) Were the instructions clear? 2) Was the program easy to use? 3) Did you like the pictures? 4) Did you learn new vocabulary after you used the program? Which ones? 5) Did you like the program? What did you like about it? and 6) Would you play with it again? Why? (Adapted from Shyu & Brown, 1992).

Results

The first research question to be answered was: How can music and interactivity found in the computer program, *"Oh I Want to be a Dog"* enhances vocabulary learning for kindergarten children? In order to determine if music and interactivity in a computer program can enhance vocabulary learning, the participants were divided into two groups to compare the results between exposure to music in a computer program and non-exposure to music in the computer program, *"Oh I Want to be a Dog"*.

Group 1 played with the program enhanced with music, but the sound was turned off for Group 2. There were four students in each group, two boys and two girls. Except for gender considerations, all students were placed in either Group 1 or Group 2 at random. There were no notable differences in academic level between participants in either group.

Overall, the students in Group 1 (music) scored higher on their first attempt at the "Dog Test", as well as their consecutive attempts at connecting the graphic to the word than did their non-music counterparts as displayed in *Table 1*.

Attempts	*Group 1 (music) Scores*	*Group 2 (no music)Scores*
1st attempt	48	28
2nd attempt	8	22
3rd attempt	4	10
TOTAL	60	60

***Table 1*: Five screens with three words per screen, students dragged the graphic to the word representing the graphic.**

In order to measure the success of the program, a t-test was conducted on the first attempt scores only. Using an independent samples t-test, it was found that in this field-test that music and interactivity has the potential to enhance vocabulary development ($t=3.425$, $p. < .05$).

Research question two explored the student perceptions and reactions toward the program. Students were asked to answer either "yes" or "no" to Questions 1, 2 and 3. All eight students responded "yes" to the first three questions and offered no further insights as to the clarity of the instructions, difficulty of the program and picture quality in these questions. Question 4 and 5 prompted more commentary and learner insight.

Student reponse to Question 4 - "What new words did you learn" varied between groups. In Group 1 (music) three students learned "jump", two learned "moon", and at least one said "dog", "human", "look", "run", "tail", and "wag". In Group 2 (no music), three students learned "jump", and at least one learned "dog", "human", and "wag". The students reponses were similar when they asked what they liked about the program: Group 1 liked music (4 students), practice with words (3 students), word test (3 students), graphics (2 students), dog actions and animation (2 students), sing with the music, and sing to remember words. Group 2 liked to practice with words (3 students), word test (2 students), graphics (3 students), dog actions and animation (3 students).

All students responded to question six (would you like to play with the program again) with an emphatic "yes". Two students from Group 1 wanted to play with it again at that moment because as they reported, they enjoyed the song and playing with the graphics and words. A student from Group 2 commented that it was fun and her family owns a dog.

Overall, the students did not differ in their enthusiasm toward the activities in the program. All of the students gave positive evaluations of the program. Group 1 had twice as many positive comments on the program as Group 2. Their comments focused on music, graphics and word practice while those in Group 2 were more interested in graphics and word practice. As results from the pilot testing indicate, the participants in Group 1 reported to have learned more vocabulary words than did the participants in Group 2, who were not exposed to music during the program.

Discussion

This investigation of the software program *"Oh I Want to be a Dog"* provided insight about the phenomena of music and interactivity in computer-aided instruction. The researcher found in this pilot testing that music and interactivity combined in CAI has the potential to enhance vocabulary learning in kindergarten children. Furthermore, results from the pilot testing indicate that the use of music in this computer program has the potential to enhance the vocabulary learning, as reported by the student participants.

Results from the t-test suggest potential responses to the first research question: How can music and interactivity found in the computer program, *"Oh I Want to be a Dog"* enhances vocabulary learning for young children. Specifically, results from Table 1 indicate that music and interactivity aids in the increase of a child's understanding of the relationship between visual and written words, spoken and written language. Groups 1 scored 33% higher than Group 2 and had a better average at getting the answer correct on their first attempt than Group 2. This finding suggests that music not only served to engage the user in the lesson, but also prompted them to pay closer attention to the target words and they were better equip to connect pictures with words in the post-test.

Table 2 reflects a notable difference between the words reportedly learned in Group 1 and 2. When asked question 4, what new words they learned, students in Group 1 reported learning 8 new words compared to the 4 words in Group 2. In addition, more words were mentioned multiple times from participants in Group 1 than participants in Group 2. Prior research supports this finding for music and extralinguistic learning (Medina, 1990). The words in a song may also provide oral support and meaning. The addition of music and rhythm helps verbal learning (Bottarri & Evans, 1982). Songs children sing can help them to learn new ideas and written words. During the test section, the researcher observed two students from Group 1 singing the song in an effort to connect the connection the lyrics with their graphical representations. Students used the music as a device to recall words and connect those words with the pictures they saw on screen. Additionally, research found that sensitivity to rhyme and along with it, the detection and production of rhyme and alliteration were related to phonological awareness to early reading skills (Bradley and Bryant 1983; Bradley & Bryant, 1985; Bryant, Bradley, Maclean & Crossland, 1989).

Questions 1, 2, 3, 5, and 6 in put forth responses to research question two, what are the student's perceptions and reactions toward the program? As stated in the results section, each student answered positively to a series of questions related to the instructions, ease and picture quality of the program (questions 1,2,3). The notable difference in the two groups is found in the answers to Question 5 and 6. The responses to Question 5 are a reflection of their group placement. It is no wonder that students in the Group 1 mentioned music as one of their favorite part of the program. It is fun, motivational and engaging. Children enjoy engaging in music when it is playful and they can respond to sounds and images (May, 1988). Through song games, children are motivated to work with letters and symbols (Richards, 1971). Groups 1 and 2 both mentioned that the practice sections and the test portion were "fun" while the graphic and animation were also mentioned favorites.

The most telling indication of motivation and enjoyment was revealed with Question 6. All students who participated in the study expressed a desire to play with the program again. Six students reported that they enjoyed the practice section. The practice section is interactive, designed to give the user control of the learning environment. Two students from Group 1 requested to play with it after their individual session was complete. Students who were in the classroom while to testing took place asked to play with the program, and commented on the bright graphics and active animation.

Part of the intrigue with the software is due to the novelty of a new product in the classroom. However, most of the credit for the success of the program is given to the music and interaction on screen. Early childhood students are extremely honest, if they did not like the program, they would have communicated this opinion. A student in Group 2 mentioned that she liked it because she likes dogs and she has a dog at home. This statement accounts for the age appropriateness of the program and keeping the scope of the project within the realm of understanding of the students. Students could identify with dogs and their behavior. Prior research supports this reflection by stating that music is effective with young children as it can reinforce what they already know (Bamberger, 1983).

Conclusion

Music represents an area where children can explore their creative sides such as playing with sound and rhythm. Children enjoy interesting sounds and often react positively to music reinforces. Furthermore, the music serves as a prompt for the planting the seeds of learning how to read. The best music programs are simple yet allow children to explore sounds, words and expand their imagination. The software *"Oh I Want to be a Dog"* fulfills these basic requirements by allowing students to use the music to explore sounds, graphics and develop their awareness of written words. Indeed, previous studies demonstrate the effectiveness of music and computers in education but few if any report the use of instruction and music delivered on a computer. This investigation provides insight for the potential of music and interactivity combined in a computer program to enhance vocabulary development.

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Object Orientation in Discourse Structuring

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Abstract: DisNet is an environment for structured communication and collaborative working, learning and playing suited for small work-groups. It conforms with the basic idea of hyper-systems in that it allows for representing context as a linked, nonlinear knowledge structure integrating multiple data types. Beyond that, "Discursive Networking" intends to organize collaborative learning and working as an open discourse and to represent the development-process of a context as a networking of contextual objects on the basis of their relations.
Contextual objects consist of a userdefinable set of relations - a frame - that describes several aspects of the object; it makes these aspects explicit and accessible. The strategy enhances hypertextuality to include multidimensional linking of objects and results in a "stratification of context". Object Orientation supports the creation, access and manipulation of these objects, in that it encapsulates data and methods; inheritance is employed on the formal as well as the contextual level. On the database-level objects are represented as tuples in a distributed tuplespace; the main methods are matching and compression (substitution by a reference).

The Hypertext Paradigm

The basic idea of inter-textuality, coined as "hypertext-paradigm", appears to be a considerable approach to nonlinear knowledge representation and a guiding principle in providing access to, and supporting the generation of context; in principle, the paradigm provides an appropriate basis also for networked collaboration. In practice, though, hypertext-implementations focus on the delivery of structured information and do not foster dynamic generation of context, and collaboration.
The ideological and market-economical reasons for this tendency are not discussed here. Another reason is implied by the node/link-principle itself, especially in its simplest form (as usually employed in hyper-systems). This simple formalism (see e.g. HyperCard) requires a consistent use of the formal elements throughout a hypertext and is therefore best suited for representing content that is homogeneous with regard to its type and characteristics, and that has a clear structure. This requirement can be met better by a single author than by a collaborating group. The need to formalize the content and to plan the structure favors the use of preproduced content material and positions most hypersystems in the domain of authoring, publishing and delivery tools.

Various solutions have been presented to overcome limitations on several levels. Some strategies build on top of an existing hypertext, using it as a scaffolding and provide write-access in allowing users to link annotations [Röscheisen, et.al: "Commentor"]; other systems enhance the hypertext organization and index the nodes to improve browsing and orientation. Other approaches enrich the formal infrastructure to anticipate contextual differentiation for example by providing several object-types, or a set of typed links [e.g. Conklin/Begeman 1988:"gIBIS", Bernstein: "MacEuclid"]. An important enhancement can be seen in the furnishing of objects with a set of attributes, as used for database-records [e.g. "Lincks"]. DisNet intends to apply the hypertext-paradigm to collaborative work, therefore several modifications to the original principle are proposed.

The Collaboration Model

DisNet stands for "Discursive networking" (the term includes a gerund to stress process rather than content, or connectivity); the model has been developed initially for educational use, where collaboration often has a discursive characteristics: given a topic, the field is explored by posing questions, forming and testing hypotheses. The participants contribute in a more or less informal manner and the teacher provides some guidance in keeping the discussion focused, hinting at important aspects and preserving a working atmosphere capable of integrating the students individuality and creativity. While current learning systems focus on retrieval, presentation and browsing of preproduced materials, learning is understood by newer learning theories rather as an effect of self-, or group-controlled activity in a problem-field.

Contributions to a discourse can be made on several contextual levels: we may distinguish between the discursive, the meta-discursive and the representational level. The discursive level concerns interactions with regard to the chosen topic; meta-discursive interactions regard formal and structural aspects of argumentation, working methods and strategies; the representational level concerns the configuration of the collaborative system, the representation of the work process and the knowledge organization it fosters. All of these aspects contribute to the context and should therefore be represented in the context space.

The standard relation between contributions in a discussion is established in that an argument refers to an argument which has been posed before. In a "round-table" discussion it often remains implicit which contribution an argument refers to and how it relates to it; this information is partially derived from the situation and the way an argument is presented. The current speaker continuously evaluates the reactions of the listener and seeks to correct misunderstandings immediately.

Especially in asynchronous, networked collaboration (which allows a participant to choose his or her own path through the network of argumentation) the intended linkage of an argument and its particular relation with another argument has to be made explicit by the author. Yet, the context is not only constituted by this argument as such, but is a multiple relationship (who said what, why, when,...). Depending on the intentions of the collaborators and the scope of a project a contextual component may be established by various relations, which may concern content-related, structural, methodical, strategical, organizational, representational, formal and functional aspects. At least the contextually most significant of these relations have to be made explicit in an asynchronous discourse, or collaboration and the collaborative environment (the context representation system) has to support this and represent the continuous differentiation of context with regard to these relations.

The Object Model

The constitutive elements of an object are usually called attributes, or properties. We speak of relations, because in DisNet objects are understood as inter-related contextual components. A relation is established and made explicit in terms of an attribute/value-pair, called "slot"; an object consists of a definable list of slots, which is called "frame". Thus the basic object in our model is the frame, which is treated as an object oriented data-structure. While in the traditional hypertext-concept the elementary objects are documents (nodes/cards) and references between them (links), in DisNet a contribution to the discourse and its relations to other contributions are values assigned to slots (argumentative multimedia material, relation-type, data-type, creation-time, title, abstract, keywords, status-flags, constraints, object-behavior, etc.). The formalism integrates an object's aspects; it deals with multiple relations (as we are used to in a "round-table" discussion).

The reason to use Object Orientation is not (as often, especially when applied metaphorically) to resemble a pseudo-materialistic "world of objects", rather it is used as in programming, as a formal scheme that encapsulates (descriptive) relations and methods (functional relations). There is no dominant constituent that represents an object; the object-characteristics emerges through the coordination of an objects internal and external relations.

The formalism establishes a formal relationship between objects and allows to generate new objects and object-schemes by differentiation of already defined objects, and it provides also a way to generalize methods for establishing, accessing, representing and manipulating object-relations and objects. While collaborative environments typically use task-, and application-specific knowledge-representation, DisNet employs Object Orientation to provide a general knowledge-representation formalism that can - with minor adaptation - be used in different application-fields.

When a new object is created it causes and represents a differentiation of the existing context it is linked with, and this differentiation is based on the contextual relations which the object makes explicit. An object is established in terms of its internal and external relations. The internal relations determine aspects such as: who said what, when, how, why...; the external relations of an object specify its connections and relations to other objects. This strategy establishes relations between objects on different levels and causes a "stratification of context".

The frame (slot-list) describes an object's relations; it provides comparable data-sets and makes contextual relations explicit - and thereby accessible. Usually, interactions in a collaboration are not easy to categorize. Forcing the user to fill out a form reduces the value of the data, because the slot-types may not always suit the object's characterization s/he has in mind. Describing an object often involves a redefinition of the categories of description. Therefore DisNet provides a userdefinable rather than a fixed set of slots: in order to make properties of a contextual component explicit the user may not only enter a slot-value but also (if necessary) define a new slot-type. In principle, a new frame-type may be defined for every object (this is not encouraged, the normal use case will manage with a few frame-types). Note, that the possible inefficiency of in-compatible frames is not necessarily an argument against this approach, because it might correctly reflect an "incompatibility" of contextual components, or disagreement among the collaborators in the categorization issue. Such problems should be addressed by the collaborators and not hidden in a rigorous formalism.

To minimize the accumulation of unrelated frame-types a new slot-type has to differentiate (override) an existing slot-type and a new frame-type (slot-set) is a modification of one defined before. By this strategy a flavor of object orientation is introduced on the discourse level, in that inheritance not only as usual propagates default-values, but formally relates contextual components. As far as useful and possible type-dependencies can be used to organize the internal structure of the frame (e.g. the relation between: title < abstract < fulltext suggest to let the title-slot of an object reference some term in the abstract, the abstract-slot some regions in the fulltext). Another technique is the reuse of object-parts, objects, or object-structures and the forming of new objects from existing objects.
The rule that a new object has to be created out of an existing object not only intends to prevent the project-space to be used as a container for vaguely related objects, but especially to contextually link an object to the reference object (insinuating a new object to be a differentiation of the referenced). This local rule is the engine that drives the generative and self-organizing collaborative process; it produces the network of contextual components.
Insofar as corresponding slot-values of objects are identical, related, or refer to each other, the slot-values of an object establish its external relations to other objects and therby specify the context. A context is determined by the history of its development which presents at any time a structure, based on the connections and relations of its components and thereby also sets the conditions for its further development.

A project initially consists of a seed-object that defines a generic frame (slot-list and the expected values as placeholders, or defaults). It may be linked with an object that contains the data and access-rights of collaborators and with an object that describes the compliance code (definition of the topic, working methods and strategies, system configuration). The initiator of the project may structure the project in advance (scaffolding) by positioning objects in the projectspace as linking-nodes for sub-topics (containers), or as templates that specify the methods to be used in the collaboration. Objects containing working material, or questions may be supplied to initiate and direct the working process.

Implementation Model

The core of the system is a database organized as a tuplespace [Gelernter 1985]. In particular it is a distributed (Linda Team), object-oriented [Eilbrecht 1995] tuplespace with a special instruction set (that provides a more direct interaction with the tuplespace and passes more control to the interface/user). The tuplespace may be distributed over several machines or media, and a local tuplespace (cache) is used by a client to minimize net-traffic. A tuple contains a reference to (a tuple that determines) the frame-type of the object and the corresponding slot-values (which may be references to other tuples). The main methods are matching and compression; compression means that redundant information is substituted by a reference.

The tuplespace model has been chosen to de-couple data from an address-based organization and to thereby allow the database to perform internal restructuring. Another reason is that a collaboration in many aspects resembles parallel processing. The tuplespace model is based on the orthogonality between creator and receiver, creation and usage: in the process of a collaboration the relation an object will have to its context at a certain time can not be determined in advance; the current "locality" (address) of an object is set by user-interactions via the interface and is therefore variable.

The modularized frame-structure reduces redundancies by reusing existing information grouped in sub-frames (e.g. containing logical, physical, temporal, personal, conver/sal, contextual, representational and processual data). It also reduces net-traffic by selective transfer ("on demand"), and by storing object-parts where they are needed (e.g. the representational sub-tuple containing the visual configuration and status-flags of an object are kept in the local tuplespace of a client).

A slot-value may contain a reference to another tuple, a valid input, or a placeholder (that describes the appropriate input, or its format), or it may contain a function (script). A general function of slots may be to parse and evaluate the input (format) provided by the user and reject inappropriate values, or notify the author.

The main operation in the tuplespace is matching. Subject to matching can be slotnames, or corresponding slotvalues (which can also be constraints). Search is performed by creating an object that specifies the particular search-values and -conditions, which subsequently places a tuple in the tuplespace and retrieves matching candidates. Search-, or filter-objects can be configured to find objects with particular properties, get an immediate or a future result (polling) and die after the result has been delivered, or can be installed in the tuplespace to permanently retrieve matching objects, or as (timestamped) questions to be answered by collaborators. When a new object is created the tuple-fields (slot-values) are matched against fields of existing tuples in order to prevent redundancy, or to notify the author of possibly related objects existing in the tuplespace. Objects in the local tuplespace (cache) are regularly matched against the corresponding objects in the global tuplespace to recognize updates. Defining the sequence of matching operations an object can be given a functionality that makes it behave like an agent.

A history-object collects the sequence of events; the type of events to be observed and the granularity can be determined. The history-object is used by a client to visualize past events (colorize visited objects); it can be edited and published and the client-functionality can be bound to its sequence of events (guided tour).

Interface: FRAMER and STRUCTOR

The user-interface is de-coupled from the database; this (Model-View-Controller paradigm) enables the user to simultaneously view and manipulate data graphically and textually. The interface is modularized, so in fact a module-family is provided for particular domains of interaction and may be combined. In the following, two of five currently specified domains of interaction will be described briefly (multimedia capabilities, context-sensitivity of menus, floating menus, etc. will be omitted):

The FRAMER is the object browser and -editor for displaying and editing slot-values of an object; it allows to browse through a project on the basis of relations between objects. The FRAMER-prototype consists of several fields and two popupmenus: one to select a slot from the slot-list, the other to choose the same slot in another object. A slot can be assigned to a field.

The STRUCTOR is an interface which graphically represents a project's object-structure. The structure can be represented in a 2D-, or 3D space (e.g. flow-diagram, cone-trees, spheres, topologies); objects are represented by graphical objects that carry a label and color-symbols representing relation-types; the user can determine the relations between objects to be visualized, e.g. as links. The representation space can be navigated, objects can be manipulated; clicking an object opens it in a Framer.

Other interfaces are provided, or can be build or configured from within the system (scripting); essentially an interface is represented by a configurable /scriptable object. The domains of interaction are coupled structurally, i.e. changes in one interface yield corresponding changes in the others; particular interactions with objects switch to a different interface, interface part or interface mode (context sensitivity).

Many multi-user environments are based on the postulate that all participants should at a particular site and time see the same data represented in the same way. Assigning priority to this kind of consistency favors a hard-wired, global worldview with the characteristics of a broadcasting medium. There are cases where global synchronization is appropriate and efficient, but in general we think that especially in asynchronous collaboration the controllability by the individual participant should be prioritized. Of course the system has to provide synchronization (data-update, data-visualization, views, functionality, system-configuration, etc.), but selective and on demand. "Synchronization on demand" is thought of as an exchange of a Compliance Code that contains information about the system state, configurations, conventions and rules, etc., on the basis of which the user, or the client decides what to synchronize.

Pedagogical Implications

The approach is in accordance with the "Projekt Methode", and with newer constructivist and sociocultural theories, in that it provides a collaborative, contextualized, knowledge-building and knowledge-using environment for learning.

The communicative structure supported by an educational network-environment has to be open to promote types of interaction that may generate the necessary collaborative dynamics; the underlying system has to establish this openness and provide transparency, configurability on several levels and adaptability to different tasks. Several dimensions of openness can be indicated to determine the structure of the domain of interaction: communicative openness implies the maxim, that all participants be equally and fully embedded in the information-flow (and are in control of this flow); operative openness allows the participants to configure the interfaces and devise the structure of communication and cooperation in a project; strategical openness is secured in that project-oriented methods and strategies may be discussed, dynamically established, or modified in a meta-discourse.

This form of collaborative learning can be typified as an open discourse. In this context a discourse is thought of as an iterative and (self)referential structure of interactions in a problem-field: it is an iterative process where new thoughts build upon previous ones, whereby a reference structure develops; and a discourse is self-referential in that the methods and strategies to be applied, its organization and scope are also made its subject (meta-discourse). The approach intends to extend the common understanding of networking as "collecting and redistributing information" towards a "collaborative generation of context".

Beyond the authority over the content the collaborators are given the responsibility for the organization and maintenance of the environment which intends to motivate a conscious and self-responsible participation.

The pedagogical goals aim at improving argumentative preciseness, acquisition of analytical and integrative competencies and developing awareness of knowledge-relations. We understand that a main feature catalyzing learning is the feedback between mutually stimulating interactions (such as orientation, interpretation, reuse, differentiation, extension, etc.)

Acknowledgments

The paper refers to the model of a collaborative environment, called "DisNet" which has been developed by [Simon, Wohlhart 1995] since 1994; it has been specified initially for an educational broadband-network project commissioned by the German Telekom and has been elaborated and reformed by the author [Simon 1996] since then.
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Virtual Lectures for Undergraduate Teaching: Delivery Using RealAudio and the WWW

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Abstract: In this paper we present details of how we delivered an undergraduate course in database systems to a group of over 100 students using RealAudio for audio synchronised with visual text, images and basic animations presented via the WWW. This electronic delivery of lectures was used as a replacement for the traditional mode and students could take these virtual lectures whenever they wanted, as often as they wanted and from wherever suited them. Our electronic courseware was organised so students could navigate through the material using a conventional table of contents, a back-of-the-book index we generated manually, or a search through the transcript of the audio dialogue. The paper discusses the benefits of organising course material in this way.

1. Introduction

The School of Computer Applications at Dublin City University is part of the Faculty of Computing and Mathematical Sciences and is responsible within the University for the subjects of computing and software engineering, as well as statistics and operations research. Our undergraduate degree program in computing, the B.Sc. in Computer Applications, has the largest enrolment of any honours degree program in computing in Ireland and has by far the highest demand for places of any computing degree in the country. Undergraduate computing facilities include a network of Pentium and P6 PCs with dual boot into either Windows NT or Solaris. Access is also available to UNIX servers and SUN workstations.

Because of Ireland's demographic distribution we have a large population of young people and an increasing demand for College education, especially in computing. Many large multi-national companies have set up manufacturing and distribution operations in Ireland as a base for Europe and the European Community and as a result the demand for higher level qualifications in computing has increased dramatically in recent years. This has resulted in increased class sizes leading to reduced personal contact between students and lecturers which is a bad thing. At present we admit about 150 students into the first year of our program annually, small by US standards but still the largest such program in Ireland. Selection of students is based on performance in state examinations and even with the numbers we admit we must still turn away bright and eager students who would gain entry in most other European countries.

"CA309: Databases" is a module taught to about 100 full-time and 20 part-time students in computing and 10 students in the B.Sc. in Applied Mathematical Sciences. These students are in the third year of a 4-year degree program. The course covers the basics of data modelling, the entity-relationship and relational models, database design and normalisation, SQL, an overview of some database products and some details on database implementation issues such as views, security, distributed databases and the system catalog. For many years the course had been taught using the traditional lecture mode of delivery with about 35 to 40 hours of lecturing, as well as laboratory assignments and an end-of-year written examination. The format for lectures was to use mass produced class materials and notes which were distributed to students, verbal elucidation of concepts by the lecturer using visual aids such as a blackboard as props, and animated explanation. This was backed up by two-way questioning between students and lecturer and informal discussion of the course at pre-arranged or ad hoc meetings.

Generalising, we can say that our educational format in this course had been typical of most University courses, a passive transfer of information via lectures with a re-enforcement of material in the library or laboratory using reference materials or exercises. With increasing class sizes and the pressure to take on even more students, even to double our intake, this trend away from student-lecturer contact was becoming even more pronounced. Such educational delivery has clear weaknesses in the area of personal contacts, distancing the student and lecturer because of numbers, and eroding the number and quality of one-on-one contacts and making most students reticent to approach lectures. In this paper we describe our implementation of a proposal to tackle this problem and we indicate the ways in which our proposal is being evaluated.

2. Using Computing Technology for Teaching

There are many ways in which computing technology can be used in education and in training such as the preparation of multimedia course material for distribution using CD-ROM. Indeed an industry of multimedia courseware production has grown up around this. Video conferencing using the internet is also becoming more and more common because of the cost factor and this can be used to deliver live lectures to remote locations. Although this has the advantage of being an interactive delivery of material, video delivery still has some drawbacks when it comes to users feeling involved with others via video links. It has been clearly shown that while computer-supported human-human interactions like attending lectures, mostly concentrates on supporting task-based activities, this is not complete without also incorporating a deliberate effort at replicating the social dimensions of human interactions such as chance encounters and group brainstorming [Bly *et al.*, 1993]. This has implications for our work.

The hottest development in using technology for education, however, is the use of the WWW for delivery of course material and student-tutor interaction and there are countless examples of such initiatives world-wide. The *World Lecture Hall* [World,1996] is an online repository or listing of such courses; and within the "Computer Science" classification there are already pointers to 94 courses in computer science on offer in various Universities, and computer science is just one off 98 such categories ! Most of these courses deliver teaching material organised as an electronic textbook or as electronic course notes which the student can "read" at his/her own pace. Some also provide multiple routes through the material, search facilities, integration of text, image, audio, video and interaction, and question-answer tests. For example, a series of "virtual" courses in Microbiology and Immunology have been jointly developed by the University of Rochester in NY state and the University of Leicester in the UK and like most such courses have resulted in the creation of electronically-available course notes. As the internet has had an increasing influence on our lives we see online course material emerging with links to other online resources like similar courses, online case studies, databases, etc. Besides the electronic provision of course material we can also find examples where technology is used to replace the classroom or lecture itself.

In our University, a course in database systems has been provided in hypermedia (text, image, audio) format since 1989. This started not as a set of online course notes but a collection of c.650 nodes of text/graphics information, woven together by hypertext links. Provided as a complement rather than a replacement for lectures, the course material was indexed and a method for dynamically generating a guided tour through the material in response to a student's query was developed [Guinan & Smeaton, 1992] To deliver this to students we developed our own hypermedia browser and evaluated this as a useful source of learning material during course revision using log files and questionnaires [Smeaton, 1991]. In 1993 the material was updated with more image and audio material and it was moved to the WWW where the guided tour mechanism was available and used primarily during course revision by students in our University and elsewhere.

What is common among the vast majority of cases of using computing for presenting course material that we have come across is that it is used either as an adjunct to traditional lectures or it is used to replace the classroom, or sometimes both [Marshall & Hurley, 1996]. Furthermore, material is organised as course notes, is low on multimedia and most importantly has not been evaluated as to its effectiveness in comparison to alternative modes of delivery. Our own efforts in this field over recent years via the guided tour navigation mechanism also fall into this generalisation. While such use of technology to present material in new ways seems to be scaleable to higher number of students technologically, in practice the higher numbers of students we are experiencing introduces new problems because we use lectures as the primary delivery mechanism to these increasing class sizes. At Dublin City University we have implemented what we believe to be at least a part solution to this issue through a series of virtual lectures and the remainder of the paper outlines the philosophy of our approach, describes its implementation and an evaluation of its effectiveness.

3. Background to Virtual Lectures

In order to address some of the problems of increasing class sizes our proposal was to use computing resources to create *virtual lectures* and to deliver material to students electronically. This is not the electronic classroom but using computers to deliver the lecture, the first time presentation and explanation of material. In effect we are creating the environment of a personal lecturer, whose voice, diagrams and sketches as drawn on a blackboard, whose animated explanations of topics, and whose course texts are delivered on screen for personalized, tailored delivery. This allows progression through material in a course as fast or as slow as the student wants to go and in an order or sequence driven by the student but guided and recommended by the lecturer. Thus the normal one-to-many lecture with its problems of class size and decreased personal contact is effectively given one-to-one, repeatedly as desired by the student. In addition to following a recommended path through the material yet with the freedom to re-visit segments of previous "lectures" to clarify aspects, to remind oneself of points or to test comprehension of topics, these "virtual lectures" are blended with tutorial sessions, more than is normally made available to students at this level, where students clarify unclear topics and follow set exercises to ensure their grasp of the material.

The tutorial sessions where students meet the lecturer to discuss course material, follow set exercises and clarify course content, are an essential part of our project. It is important for us to address the social consequences of students not attending class as part of a large group and we do this with group tutorial sessions which provide an opportunity for socialising, brainstorming and chance conversations. Because the databases course is one of 6 subjects taken by students where the other subjects are delivered in traditional mode we are confident students do not feel isolated..

The obvious benefits that a series of virtual lectures have are that students take control of their own learning and do so at their own rate, albeit moderated by the lecturer in charge of the course. The passive transfer of information as conventional lectures have become in times of large class sizes is replaced by personalized delivery, with the student determining when, what, how fast, how much and how often material is covered. The re-enforcement of material in tutorials leads to a broader skills base with students working better during tutorial sessions. In our mode of delivery, tutorials assume a more important and central role than otherwise as they become the major point of contact among students and between students and lecturer.

In defining the mode of delivery we now call virtual lectures it was important for us to replicate the lecture mode of delivery as closely as possible so as to minimise the culture shock students experience in moving from group participation in one-to-many classes to individual and user-controlled participation with virtual lectures. Our own experiences with making a hypermedia version of our course available to students over the last 7 years has been mixed with only some students really embracing the technology. This was partly because it was new technology but partly because people are not always comfortable with only a hypertextual organisation of material [Smeaton, 1991] despite the supposed advantages hypertext organisation has of user control [Marshall & Hurley, 1996].

Before we present details of our implementation there were some compelling reasons why we chose the course on databases as given to third year computing students, for this work. One reason was that these students were already quite familiar with Netscape and the WWW and so had no learning curve to climb in using the delivery tools. Also, these students already had a computing culture with the use of PCs on an individual or pairwise basis being an integral part of their daily lives. This is not so true for subjects in science, business or humanities subjects at our University. Finally, the School which is responsible for presenting this course already had the networking infrastructure in place, PCs with soundcards to deliver the material, and the technical expertise from previous projects to create, update and maintain the material as well as maintain the WWW and RealAudio servers.

4. Details of our Implementation

The contents of the database course have been re-organised into a series of segments or topic points. In traditional lecture mode of delivery, each of these would be an audio presentation synchronised with some visual props and question-answering with students. To replicate this closely, each segment is presented as a RealAudio track of between 2 and 20 minutes in length. Because we use a RealAudio server and RealAudio players on multiple platforms we can synchronise the presentation of material on Netscape or other WWW browsers using specification files as input into the server which detail when URLs, corresponding to visual material, are to appear in the user's WWW browser during audio playback. During playback users may also pause their virtual lecture to transcribe, take notes, rewind etc., using their paper copy of the screendumps which have been distributed to them. The set of segments comprising the course have been gathered into chapter-sized units for easier navigation. Each student has his/her own unique login identifier to the course material and on login are taken to the latest news of assignment deadlines, new materials online, place and time of tutorials, exam results.

Students are free to browse the material in any order using one of 4 navigation ways:

1. There is a complete hierarchical table of contents for the course and the lecturer recommends a progress rate through the material using this. This organisation is close to what is done in traditional lectures, moving from topic to topic within the hierarchy and for each topic playing the RealAudio segment.
2. There is a comprehensive topic index, like a back of the book index, with for each entry, multiple pointers to offsets within RealAudio segments for a topic. On clicking these offsets, the user is taken to just before the offset within the RealAudio track where the instance of the topic is covered.
3. We have generated a full transcript of the complete audio track, removed stopwords and stemmed remaining words and from this we provide a search facility for segments of audio. We have divided the audio tracks into 30 second segments, overlapping by 10 seconds and appearing like a sliding window through the audio. We treat each segment as a retrievable unit with higher weights for words in the middle of each 30-second segment. The search is implemented using a search engine developed in our Multimedia Information Retrieval research group [Smeaton &Kelledy, 1996]. The result of a search is a list of 30-second segments for the user to chose 1 or more to play. This is useful at revision time or when students are forming an overall picture of the course.
4. The visual material appearing onscreen is HTML and contains hypertext links to other parts of the course. Thus, for example, the text on-screen for a description of the SELECT operator in the relational algebra includes the following: "... this is not the same as the SELECT statement in SQL ..." with SELECT being an anchor for a link to that topic and SQL being a link to that topic. This allows students to browse through the material using the web of hypertext links.

The audio we use has been digitised using Cool Edit! sampled at 22KHz in monophonic format and saved in 16 bits WAV format. It is then encoded in RealAudio 14.4 format which we use instead of 28.8 because 14.4 has been optimised for speech. The audio is made available as a stream from our RealAudio server running on a SUN Ultra Enterprise 2 server on which our WWW server for the course material also runs. The networking and computing power of this set-up would allow us to handle much more than our current maximum of 50 simultaneous users. Needless to say there is a consistent user interface for screens with feedback and comments, next, previous, home, table of contents, index and search buttons always onscreen.

To reduce disruption in computing laboratories caused by audio over speakers, each student has been issued with a set of walkman-style headphones. All user interactions are logged for subsequent analysis. We had initially planned to use Java applets for animation in the course but have found that when we want to illustrate this then multiple GIF overlays in GIF89a format is adequate for our needs.

5. Analysis

The virtual lectures for CA309: Databases has been operational since the end of September 1996, with almost 150 students using the system as their mode of delivery for this course. Rather than being a technically-driven initiative, we include a considerable element of evaluation in our work. Students have completed a pre-course questionnaire in order to determine their familiarity with WWW and RealAudio, as well as their preferred locations for accessing the system. As each student is issued with a unique login identifier, all student interactions are logged and timestamped, on a per user basis, allowing detailed analysis of usage. Finally, students must participate in 6 or 7-person focus group interviews coupled with post-course questionnaires, both anonymous and named, in order to gain insight into what they thought of the system. The focus group meetings last 30 minutes and follow a hidden agenda of questions to be discussed in order to elicit students' opinions on aspects of the virtual lectures mentioned below.

When considering how to analyse our virtual lectures there are 3 aspects we must consider in parallel, namely:

- The performance of students
- The usability of the system
- The scale of investment needed to create and maintain virtual lectures

The performance of students is a measure of how well they have learned from virtual vs. traditional mode of lecture delivery. The obvious metric is performance in examinations but this is inadequate because there are so many variables to be considered, the learning ability of classes from one year to another, the relative difficulty of exam papers, etc. The opinions of the external examiners, whose role in our University is to ensure quality standards in teaching and in student performance are adhered to, will be included here, but we feel that there is little more we can do for this aspect of evaluating virtual lectures.

The usability of a system can be measured based on 5 criteria, according to [Nielsen, 1993] as outlined below.

1. Learnability refers to the user's ability to quickly learn how to use a system. In our case we measured how familiar students are with WWW and browsers and RealAudio before the course commenced, and in post-course focus groups and questionnaires we measure how quickly students learned how to use the index, search, table of contents, etc.
2. Efficiency of use in our case can be quantified by computing the amount of time spent by students using virtual lectures vs. the time they would have had to spend in traditional lectures. We have found that material is much more concentrated when presented virtually and as a result we suspect students may need to re-take parts of lectures to improve their comprehension, and on balance the amount of time spent in both modes of delivery might be equal.
3. Memorability is a measure of student's ability to grasp material quickly and to quantify this we can determine from log files and questionnaires, how much revision of the online material was taken.
4. Errors refer to the number of minor corrections (typos, HTML formatting, etc.) and major problems (system downtime, system failures) and this can be counted from log files and from user feedback.
5. Subjective satisfaction with the virtual lectures will be measured using post-course questionnaires containing Likert scales and semantic differentials for the major features in our system.

As we can see, for each of Nielsen's usability criteria we do have some kind of evaluation mechanism in place.

The final aspect of the evaluation of our work concerns the scale of investment needed to create and maintain virtual lectures. A material investment in equipment was needed for things like the machine on which the WWW and RealAudio servers run, the RealAudio server itself as well as other software for creating graphics for example, and the purchase of headphones for students. All of these have proved to be useful for other teaching activities; the lectures for a final year undergraduate course on multimedia systems is being digitised and made available on the equipment obtained for the virtual lectures project.

The big investment in creating the virtual lectures has been the time required. One full-time research assistant worked for 9 months on this project, setting up the servers, marking up the HTML, setting up and maintaining student accounts, troubleshooting, evaluating log files, conducting and analysing questionnaires, etc. The lecturer was also required to put in more effort for the virtual lecture delivery than for a traditional mode. On the plus side, the virtual lectures are now in place and re-usable for next year's teaching of the Database course, but would probably require revision and update after that.

6. Conclusions

The conclusions from the work we have reported here remain a little bit unknown; we don't know whether the way in which we have implemented virtual lectures works. What we do know is that the technical challenges have been overcome, in its operation the course delivery works smoothly but it remains to be seen whether the students have learned the material and how they regard the usability and effectiveness of the system.

There are some other points worth mentioning as conclusions for our work. In order for the virtual lecture to work, the course for which it would be used should not be a first year course as students would still be familiarising themselves with the computing environment. Furthermore, it should not be a final year course as these tend to be more interactive and are critical to a student's final degree classification. CA309 was ideal for virtual lectures as the topics covered remain fairly static over a few years and do not require major overhaul and update on a regular basis so we are happy that we chose the right course for this.

Our virtual lectures are not what is called distance education, though the technology we use can be used for that. We maintain close contact with students who work together in groups on campus as but whether our mode of virtual lecture delivery could be used for distance education courses is not something we address.

Finally, would we repeat the exercise of providing virtual lectures again, for other courses ? Certainly we have fully grasped the technology for doing this and were we to repeat it we could complete the task in less time than the first time took. While the investment in technology to deliver virtual lectures is becoming less of a requirement, the manpower effort required remains considerable and is considerably more than for delivering a course traditionally. Some of this investment is paid back when multiple runnings of a module use the same virtual lectures but with the cost of updating virtual lectures and personal interaction with students still required, delivering virtual lectures the way we do is not a cheaper alternative to traditional course delivery. Our virtual lectures are useful because of the multiple ways students have to access lecture material online at times that suit the students and not because they are a cost-reduction exercise for the University.

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A Framework of Remote Telescope System by WWW with Computer Assisted Guidance and Instruction

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Abstract: We have started a project of making remote control system for a telescope in a public observatory in Japan. A remote client user can put in the celestial position of a target by the web home page of the system, and the telescope catches the target. The main purpose of this system is to show real time images to remote students for education. This system suggests CAGIS (Computer Assisted Guidance and Instruction System), which distinguishes this system from other remote control systems. If this system is used from high schools in western countries such as Europe or U.S.A., the students can see real time images of celestial bodies and celestial phenomena in the school hours. If this system is used from southern countries such as Australia, the students can see northern celestial bodies that is never seen from those countries. Therefore this system will contribute science education internationally. We are developing this system now, so it is not completed yet. In this paper, we describe concept and architecture of our remote control system of telescope with CAGIS.

1. Introduction

Recently in Japan, attractive science education is necessary for students, since many high school students don't want to study science. One of the largest reason of it, is that the lectures of science in high schools are not interesting, because they are only inputs of knowledge by text books without observation of real objects.

In this situation, celestial phenomena and celestial bodies seem to be prominently attractive, especially for young generation, because many planetariums and public observatories are always crowded with young generation. Although astronomy is a part of earth science in the curriculum of Japanese high school, it is not educated enough. Because it is impossible to show real celestial phenomena and celestial bodies to students in school hours, since most celestial phenomena and celestial bodies are seen in the night sky. On the other hand, these ten years, a lot of public astronomical observatories are established in Japan, and the total number of them is around two hundreds. Around fifty observatories among them have telescopes of more than 0.5-m, and four of them have telescopes of more than 1.0-m. Misato observatory in Wakayama prefecture in Japan has 1.05-m telescope, that is the largest one among Japanese public telescopes. On the other hand, only two public observatories in Japan connected to Internet by digital leased lines. Misato observatory is the first one among those two observatories. Misato observatory and Wakayama University have already been cooperating to try some new attempts for education by Internet and video conference tool[Watanabe et. al.1996a, 96b].

In these environments, we have started the new project to make remote control system of the telescope by using WWW for educational use. In this project, we prepare five servers, web server, telescope server, telescope camera server, wide view video camera server, and CAGIS (Computer Assisted Guidance and Instruction System) server. Remote client students access the web server, and get home page of remote telescope project. The student can select a target in a pop up menu, or can put in the celestial position of a target. Then the web server transfers the position to the telescope server. Then the telescope server moves the telescope to the direction of the target. A video CCD camera is set on the telescope. After getting real time image of the target by the CCD camera through the telescope, the image is transferred to telescope camera server. The telescope camera server transfers the image to the client student.

There are some other remote control systems of telescope for astronomical research use. The Berkeley Automatic Imaging Telescope (BAIT) by M.W. Richmond, R.R.Treffers, and A.V.Filippenko, is the system that performs all its tasks with minimal human intervention[Richmond et. al. 1993]. Colgate S. and his group in New Mexico Tech developed a system for Digitized Astronomy Supernova Search[Colgate et. al. 1982]. Smith C.K., Muller R., Pennypacker C., and their group in Lawrence Berkeley Laboratory also developed a Supernova Search telescope[Smith et. al. 1988][Perlmutter et. al. 1990]. Tosti G., Pascoloni S., and Fiorucci M. in the Perugia University developed the Automatic Imaging Telescope (AIT) using existing 0.4-m telescope with autoguider[Tosti et. al. 1996]. The purpose of these systems is to reduce astronomers' load. Astronomers can drive the telescope from remote room with comfortable environment. In the supernova search, for instance, astronomers only have to put in some job schedule of getting images of the sky by CCD camera, then the telescope system executes the job automatically.

On the other hand, a few remote telescope systems began to be made for educational use. Especially, Mar J.Cox and John E. F. Baruch in University of Bradford have developed excellent system that can be used on WWW[Cox et. al. 1994]. However their system attaches greater importance to technology of full-remote control than to education system. Also, their thesis is lacking in consideration how to apply the remote telescope to education. A part of our system is similar to their system in the architecture of remote control with WWW, but our system suggests to combine the remote telescope system with CAGIS (Computer Assisted Guidance and Instruction System).

In this paper, we describe the concept of our remote telescope project, architecture of our remote control system, and CAGIS. We are developing this system now, so it is not completed yet. When this project is finished, the telescope can be controlled from all over the world, When Japan is at night, foreign countries such as USA. or Europe is in the daytime. Therefore those who live in the countries can see real time image of celestial bodies at the daytime. This remote telescope system can be used at schools to teach science, and can be used in the planetariums for visitors in the daytime in the foreign countries. This global idea is proposed by some projects of remote telescope for education use, such as HOU (Hands On Universe) project[1]. Also, from southern countries such as Australia and South Africa, they can see the real time images of celestial bodies in northern sky, which is never seen from those countries. So this project will contribute science education internationally.

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[1] http://hou.lbl.gov/

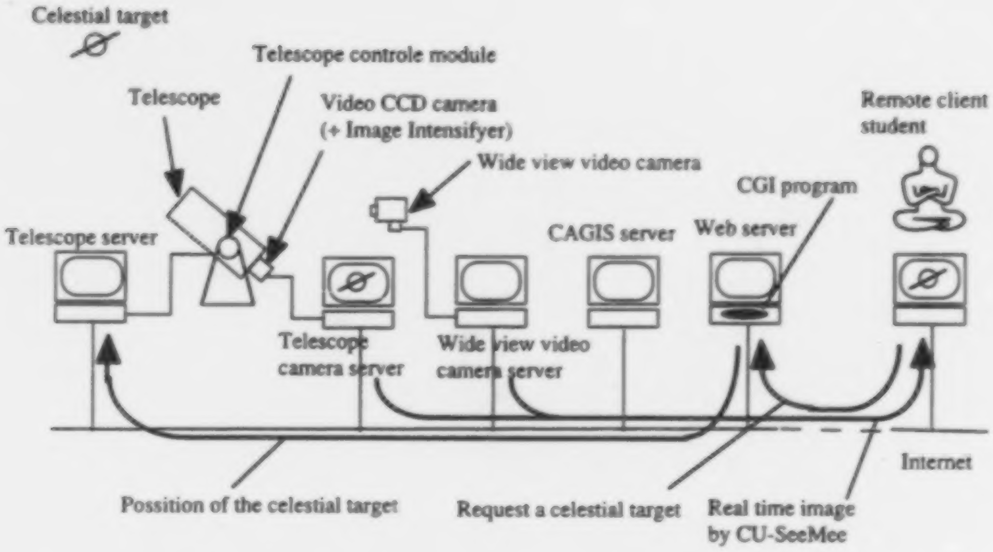
Celestial target
Telescope controle module
Telescope
Video CCD camera
(+ Image Intensifyer)
Remote client
student
Wide view video camera
CGI program
Telescope server
CAGIS server
Web server
Telescope
camera server
Wide view video
camera server
Internet
Possition of the celestial target
Request a celestial target
Real time image
by CU-SeeMee

Figure 1: The architecture of the remote control system of the telescope with CAGIS

In this paper, we finally describe how to apply the remote control system to education. Also, we expect that students will be interested in not only astronomy and science but also Internet, WWW and computer science. HOU project and TIE (Telescope In Education) project[1] also make some science program combining astronomy and engineering. We also think that it is possible to make original combined curriculum of astronomy and computer science with this remote telescope in Japan.

2. User Interface by Web Page and Mechanism of Moving Telescope

[Fig.1] shows the architecture of the remote control system of the telescope with CAGIS. The user interface is made by web page with HTML on the web server, and it has pop up menu to select a target, and some blank to put in celestial position of the target. A student selects a target, or puts in the position of the target that he/she wants to see. This position is described by equatorial coordinates. Then the position is transferred to the web server, and a CGI (Common Gateway Interface) program in the web server gets the position. The CGI program calculates the sidereal time, by the Japan standard time, latitude and longitude of the observatory. Then the CGI program transforms the position of the target on equatorial coordinates into horizontal coordinates. If the altitude of the target is more than 20 degrees, the object can be seen in the sky clearly. If the altitude is less than 20 degrees, the object is seen low in the sky or cannot be seen because it is under horizon. In this case, the CGI program replies a message "The target celestial body cannot be seen, because it is too low in the sky or under horizon" to the student. Even if the target is seen lower in the sky, it is dangerous to move telescope towards such a target, since there is possibility that the telescope crashes into objects in the dome.

If the target is seen in the sky at the safe direction for the telescope, the CGI program transfers the position of the target to the telescope server. The telescope server calculates the difference between the position of the target and the current direction of the telescope. Then the telescope server sends necessary serial signals to the control module of the telescope. Finally the telescope is moved toward the direction of the target.

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[1] http://www.mtwilson.edu/Science/TIE/

3. Video CCD Camera and Wide View CCD Camera

A video CCD camera is set on the eyepiece of the telescope. If the target is very bright one, such as the moon, Jupiter, or Saturn, the video CCD camera is enough to get the real time image. If the target is not bright one, such as a galaxy, nebula, and cluster of stars, an image intensifier is necessary between the eyepiece and the video CCD camera. By this composition, real time images of famous galaxies, nebulas, and clusters of stars in Messier catalogue can be gotten.

The real time image of the target is sent to the telescope camera server. Then the real time image is sent to the remote client student by a video conference tool such as CU-SeeMee. If the image on the client is too exposed or less exposed, the student can change the exposure from the web home page of the remote control system.

On the other hand, wide view video camera is prepared for getting real time image of inside of the dome. It catches the real time image of which the telescope is moving according to the student's request. The wide view video camera is also used to see weather condition of the sky. It shows where the sky is clear, or where the sky is clouded. The real time image of the wide view camera is sent to remote client student also by a video conference tool such as CU-SeeMee.

4. CAGIS

In the domain of celestial bodies, the position of the target on the equatorial coordinates is decided uniquely by the time and date. On the other hand, the direction of the telescope on the equatorial coordinates is easily calculated. Therefore it is easy to know where the student is observing in the target. By these things, it is possible to make CAGIS (Computer Assisted Guidance and Instruction System) for the student. Here we explain the mechanism of the CAGIS, using observation of the Moon as an example.

[Fig.2] shows the mechanism of CAGIS. It has two knowledge bases, domain knowledge base and operation guidance knowledge base. Domain knowledge base has many frames. Every frame has every domain knowledge. In case of the moon, domain knowledge is explanation of every part of the Moon, such as a crater and mare of the moon. A frame consists of three items. The first item is the location of the part on the selenographic coordinates. The second item is the name of the part, such as a name of specific crater or specific mare on the moon. The last item is the explanation of the part. In case of a crater, it is diameter, height of the rim of the crater, and origin of the crater.

The location of the part on the selenographic coordinates is used as a key to select adaptive frame from the domain knowledge base. How to select adaptive frame is as follows. Suppose that the student is observing a part of the moon. At the first, CAGIS transforms the direction of the telescope on the equatorial coordinates into the selenographic coordinates. Then CAGIS retrieves the frame which location is the same as or close to the direction of the telescope. After that, CAGIS calculates the age of the moon, and decide whether the part of the moon is bright or not. If the part is bright, CAGIS show the name and explanation of the part to the student. If not, CAGIS does not show them.

On the other hand, operation guidance knowledge base also has many frames. Every frame has operation guid-

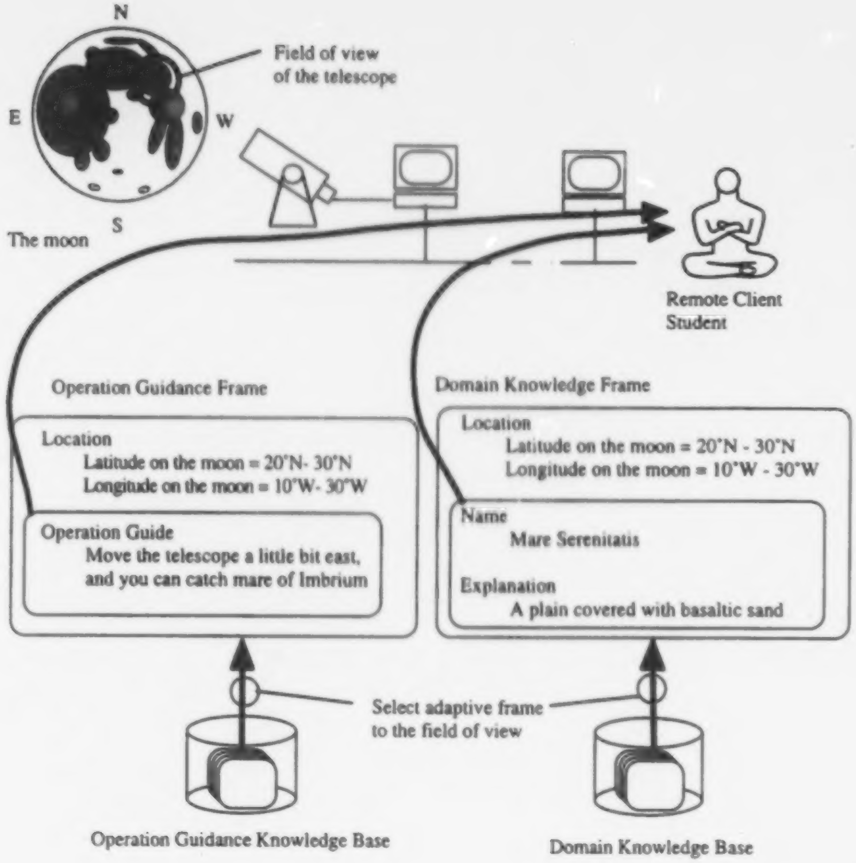
N
E
W
S
The moon
Field of view
of the telescope
Remote Client
Student
Operation Guidance Frame
Location
Latitude on the moon = 20°N- 30°N
Longitude on the moon = 10°W- 30°W
Operation Guide
Move the telescope a little bit east,
and you can catch mare of Imbrium
Domain Knowledge Frame
Location
Latitude on the moon = 20°N - 30°N
Longitude on the moon = 10°W - 30°W
Name
Mare Serenitatis
Explanation
A plain covered with basaltic sand
Select adaptive frame
to the field of view
Operation Guidance Knowledge Base
Domain Knowledge Base

Figure 2: The mechanism of CAGIS

ance explanation. It guides surroundings of the position where the telescope catches. In case of the moon, surrounding craters and mares are guided.

5. Conclusion

In this paper, we described the concept and architecture of our remote control system of a telescope with CAGIS on WWW. The purpose of our system is education use. Therefor the system does not need to realize full-remote control, although a telescope for research use needs it. In the full-remote control system for research use, dome is also controlled from remote site, but it is not so necessary for education use. The main reason why we try to realize remote control, is to increase student's feeling as "using telescope by oneself", and to increase student's interest. Only a part of the celestial body is observed at a moment by a high magnification, if the celestial body is large, such as the moon, Andromeda galaxy, or Orion's nebula. In such a case, it is important that the student can control the telescope according to his/her desire, since the remote control brings him/her the feeling of voyaging in the space.

CAGIS helps such a voyage. On the other hand, if a staff is in the dome, it is possible to move the telescope by the staff according to the request from a student by phone call or e-mail. However this kind of system is not so interesting for the student, since it has less interactive feeling.

It is desirable that remote telescopes for education exist as many as possible in all over the world, because weather condition is not always good in one observatory. If there are many remote telescopes, some of them can catch the target in a good weather condition. For another reason, the view of celestial phenomena by the moon, is dependent on the location on the earth. For instance, a total solar eclipse can be seen in a narrow zone where the umbra by the moon passes on the earth. In neighbor area of the zone, partial eclipse can be seen. Therefore, if there are many remote telescopes on the earth, from an observatory in the zone of totality, the real time image of total solar eclipse can be sent to remote clients. On the other hand, from another observatory in neighbor area of the zone, the real time image of partial eclipse can be sent. If a remote client student receives some real time images from some observatories on the world, he/she can understand the difference of view of the eclipse. Also he/she can understand the umbra and penumbra passes on the earth as tume passes.

Eclipse of the sun is quite rare phenomenon, but occultation of stars by the moon can be often seen. As well as the eclipse of the sun, the view of occultation of a star depends on the location of the observatory. The point and time of disappearance and reappearance of the star against the moon differ according to the location of the observatory. Therefore if a student compares some real time images of occultation of the star from some different observatories, he/she can understand and measure parallax of the moon. By the parallax, it is possible to make an education program to calculate the distance between the earth and the moon. This kind of education program is a desirable science program. Because it includes observation phase of real objects and consideration phase of the observation. It enhances ability of observation of real objects and ability of consideration and study.

CAGIS is our original idea, that gives some explanations and guidance of the target. It helps the student to drive the telescope, and gives some useful information. It is also possible to put in questions instead of explanations in the domain knowledge frame. In this case, CAGIS become another type of CAI system, that consists of questions and answers. It will be an excellent CAI system that utilizes real time image as teaching material. It is our future work.

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MANIC: Multimedia Asynchronous Networked Individualized Courseware[1]

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Abstract

The MANIC project in the Department of Computer Science at the University of Massachusetts is aimed towards facilitating individualized asynchronous distance learning. We take advantage of current technology, such as the World Wide Web and high-speed networks, to present a rich combination of text, graphics, and sound. We use student modeling to aid in the presentation of the material, including individualizing the instruction for each student and reducing the delays by predicting what the student will see next. In this paper, we present the initial work on the MANIC system and discuss the future possibilities and research.

1 Introduction

With rapid advances in telecommunication technology, distance learning is fast becoming a viable adjunct to the standard classroom model of learning and teaching. The MANIC project is an attempt to harness the power of general purpose computers (e.g., web servers), networking technologies (e.g., the Internet and higher-speed local area networks), and information presentation tools (such as WWW browsers and multimedia browser plug-ins) to create an asynchronous multimedia learning environment. Specifically, we are exploring how to most effectively use WWW multimedia technology (HTML and audio/video browser plugins such as RealAudio together with customized WWW servers) to deliver stored course or training materials such as class notes/overheads and audio/video of classroom lectures to students.

There are two ways of presenting educational material on the web: synchronous and asynchronous. Synchronous distance learning environments focus on creating an illusion of a classroom. This includes the delivery of live classroom lectures via satellite channels and video recordings of live classroom presentations. Internet-based conferencing tools have also been used to create live, networked distributed "classrooms" [Liebeherr et al. 96]. On the other hand, asynchronous systems are designed to allow students to use the software at any time, without simulating a classroom. With these systems, students proceed at their own pace and are not assumed to be accessing the same material at the same time as others. The goal of these systems, such as the system described in [Rebelsky 96], is to serve as an easy-to-access repository of reference material.

Our focus in MANIC is also on *asynchronous* learning environments, so students can access the software at any time without regard to others also using the software. Thus, while the synchronous distance learning approach attempts to recreate the classroom by connecting together distributed participants in real-time, our focus is on delivering *stored* multimedia materials and past classroom activities to distant students.

Given our focus on asynchronous student access, the goals of the MANIC project are threefold. The first goal is to develop *effective* WWW-based stored materials and presentation paradigms – to learn what does, and does not, work well by implementation and experimentation. Because we assume that a "live" instructor is not on-line with the student, our second goal is to develop student modeling and intelligent tutoring capabilities that allows the software to interactively guide a student through the stored material, providing individually tailored instruction for each student. The third goal of the

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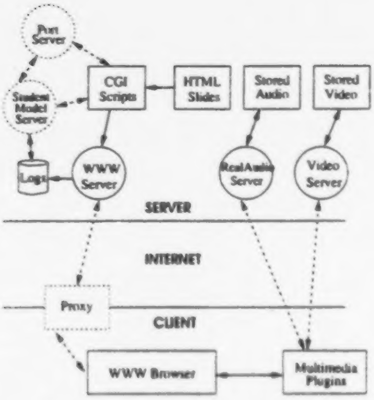

Figure 1: MANIC structure

project is to use MANIC as a testbed for research in the areas of multimedia networking and operating systems. In this paper, we focus our discussion on the first two goals.

In this paper we describe our initial efforts in constructing MANIC, focusing on both the software and the course materials we have developed. We also discuss the various larger lessons we have learned thus far. Although the MANIC project is still under development, a preliminary version of the system was used in a for-credit course being offered in the Fall of 1996 at the University of Massachusetts (`http://www-aml.cs.umass.edu/~amldemo/`), with additional courses currently using MANIC software in Spring of 1997 (`http://www-aml.cs.umass.edu/~cs653/`). Since the courses were taught in the VIP studios, we were provided with professional-quality recorded audio and video of the live classroom activities, which were then digitized.

The remainder of this paper is structured as follows. Section 2 overviews the hardware and software components of MANIC, as well as how course materials used for MANIC are created. Section 3 describes the various student-oriented features that we have built into MANIC and discusses their implementation. Section 4 describes future plans for the project. Section 5 concludes the paper.

2 MANIC: multimedia, asynchronous, networked individualized courseware

Currently, MANIC delivers text (HTML documents and still GIF images) synchronized with audio (encoded and delivered using a RealAudio server) over the Internet to students with multimedia capable machines with WWW browsers. This architecture provides for a traditional classroom like learning experience (unlike [Rebelsky 96]), but also allows for asynchronous learning (unlike [Liebeherr et al. 96]). RealAudio codes audio for potential delivery over 28.8Kbps dialup lines and hence MANIC course materials can be accessed at home, at school, or at work. Our design also has provisions for a video server (MPEG) to be added as well, and we are currently adding this functionality. In this section we first overview the MANIC hardware and software components.

MANIC makes classroom materials, including the HTML of the instructor's class notes (overheads provided by the instructor), classroom audio and classroom video available to students over the WWW. Initially, the notes we used were exact duplicates of the paper notes (specifically, a copy of the class overheads used by the instructor) used by in-class students. However, we soon realized that the on-line notes could (and should) be augmented with embedded hyperlinks to related material.

The course that we have already made available on-line via MANIC is a six-hour course on UNIX Network Programming (that was taught by J. Kurose in May 1996 in the studios of the Video Instructional Program (VIP) at the University of Massachusetts and distributed via the National Technological University).

The MANIC architecture is shown in Figure 1. On the server side, MANIC is built around a standard WWW server, with customized common gateway interface (CGI) scripts that generate, "on the fly", the

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HTML document to be sent to the client. As we will see shortly, the ability to generate/customize a document on the fly allows the server to dynamically and individually tailor a document for an individual student. Currently, our primary use of this tailoring is to highlight selected portions of a document in synchrony with the audio.

The client accesses the course material using a WWW browser (such as Netscape Navigator or Internet Explorer) and the RealAudio and other multimedia plugins. The WWW server sends HTML text to the client browser. An audio stream is also sent to the client plugin by our separate RealAudio server. Audio playout and HTML presentation are synchronized and controlled at the client computer using the synchronized multimedia feature provided by the RealAudio server/player. In this paper, we will not discuss the intricacies of the multimedia synchronization mechanism nor the HTML interface programming required to integrate control of HTML and audio together in the browser's display; the interested reader is referred to [Kurose et al. 96].

The client-side components of MANIC are all "off the shelf" pieces of software. Indeed, one of our design criteria in building MANIC was that we *not* develop specialized client-side software beyond some simple Javascript programs. Instead, we leveraged WWW browser and plug-ins (such as the RealAudio client, which is available from RealAudio as a free download) as much as possible. This not only minimized our own software development effort, but aided in portability as well – companies that make browsers and plug-ins naturally want to make their products available on as many platforms as possible. Using off-the-shelf client software allows any student with a multimedia PC, WWW browser, and an Internet connection to use MANIC without having to download any MANIC-specific software. In retrospect, this decision to leverage existing client-side software and focus our development efforts at the server side was a good one.

There are two optional pieces to the architecture. The first is the student model server, which keeps track of activities of individual students and constructs a model of the student's behavior. This model can be used to customize the course material to tailor it to individual student's need (done on-the-fly). The second optional component of MANIC software is the proxy. As shown in Figure 1, the proxy is neither at the client nor at the server. This piece of the software is primarily used to reduce the response time (download time) of client requests. The proxy is advised by the student model server on the documents a particular student is likely to see next. The proxy prefetches this document from the web server and stores it on a local disk. If the "guess" made by the student model server is accurate, the download time for the document will be negligible, as the proxy will be able to serve the document from its local cache [Padmanabhan & Mogul 96].

3 Features of the MANIC Environment

In this section we describe the user's interaction with the MANIC system as well as the features of the system that enhance this interaction.

3.1 Non-linear perusal of course material

A design goal of MANIC was to allow students to have an active role in the way they see the instruction. Interactivity is important in order to keep students interested in the material [Hannafin & Sullivan 95]. To provide for interactivity, students are given the opportunity to browse the material at their own pace, stopping and starting the audio at will. However, students also have the option to view the material as they would in a traditional classroom (e.g., where synchronized audio and HTML playout continues non-stop for 60 minutes or more). Students can switch between either mode at any time; they are not restricted to only one mode of interaction. When a student begins browsing after having listened to the audio, the playback is stopped. The student must then begin the audio again explicitly if desired.

Because we want to allow students to browse the material in a non-linear fashion, we have decided to include a method in which students could jump to other parts of the course easily [Eklund 95] For this reason, we have included a table of contents which allows students to see the structure of the material as well as to jump to new material with one mouse click. We have also added an index of topics as well as a text-based topic search engine. To further allow for easy browsing, we have added "next" and "previous" buttons to each slide. These buttons link to slides immediately following and immediately preceding the current slide, in the linear ordering. In this way, students can linearly browse through the course without relying on the index.

Since students may be browsing the material, they may want to hear the audio for only one slide and no others. Therefore, we have designed two play modes: play continuously from the currently displayed slide onward, and play the audio for the current slide only. The first mode will play the audio from the current slide and continue until the user stops the sound, automatically changing the slides during the playback. The second mode will play the audio only until the end of the slide is reached.

3.2 Highlighting of course material

The earliest versions of MANIC simply displayed a static HTML page while the audio associated with that page was being played out. It soon became apparent, however, that such a static display was rather dull. To make the material more interesting and to capture/focus the student's attention, we chose to dynamically highlight selected portions of text within the single "page" of notes displayed by the browser. Now, as the audio progresses through the displayed page, the highlighting within the page changes. This helps the student to follow the material on the slides while listening to the audio.

Dynamic highlighting is achieved by downloading a different HTML document each time the highlight changes. Thus, several documents may contain the same basic text but will have different portions of the text in the highlight color (red). The repeated download of HTML documents proved to be problematic over 28.8K modems. Half of the bandwidth was occupied by the audio stream almost all the time. The remaining bandwidth proved to be too little for effective downloading of the new document each time the highlight changed. This led us to provide an option to the user whereby the material can now be viewed with or without highlighting. In general, we have decided to categorize users by bandwidth, CPU processing power, and memory available to them.

3.3 Displaying supplementary material

Simply putting the slides and audio on line without any changes is rather shortsighted. While traditional classrooms require linear delivery of material, the WWW allows for non-linear presentations. To take advantage of this, we have added the index as well as hypertext links to supplemental materials. The hypertext links present related information to the student, sometimes in the form of review material and other times in the form of interesting sidenotes.

However, when students access additional material, they should not lose the original context [Stinner 95]. Therefore, when a student clicks on a hypertext link or chooses to view the index, an additional window is spawned to present that material. With this method, students can view all the information simultaneously.

3.4 Putting user controls in HTML documents

As discussed in section 2.2, the RealAudio player is actually the controlling application on the client side. However, the RealAudio player provides a cassette-deck-like interface to audio. Some RealAudio controls, such as those that start and stop audio/HTML playout are appropriate for a stored delivery system such as MANIC. Other aspects of the RealAudio interface are not appropriate. For example, the only way to index into audio using a RealAudio player is by time (e.g., "move the playout to 35 minutes and 16 seconds into the audio"), whereas a better method for indexing into material is by content (e.g., "move forward to where the instructor begins covering a specific topic"). In addition, user commands for requesting help and sending in commentary on MANIC are also required.

Thus, we decided that user controls needed to be placed within the HTML documents (i.e., displayed and accessible in the "page" of notes being displayed in the WWW browser) rather than via the standard RealAudio control. In essence, we "hid" the RealAudio control interface from the student using our own control interface instead. Each of the control buttons in the MANIC interface activates a CGI script on the server which forces the RealAudio client and server to perform the requested operations.

3.5 User tracking and intelligent tutoring

One of the long term goals of the MANIC project is to provide the users with training material tailored to their rate of progress and other individual preferences. To achieve this goal it is essential to keep track of actions taken by individual users. The HTTP communication protocol does not support this as it is a stateless protocol. Hence single-session cookies [Gundavaram 96] were used to create a "session" out of the stateless HTTP protocol. The cookies carry information such as user login name and visual preferences and allow user-specific actions (such as logging information in proper files) to be taken.

The same mechanism allows us to distinguish between registered and unregistered users. Registered users are required to fill out a small HTML form at the beginning of each session. The form and the associated CGI script captures and sets the user id in the session cookie. If this information is not present, the user is considered to be an unregistered user. Using the information in the user id field of the cookie, it is possible to track users' progress, their access patterns etc.

4 Future Work

In this section we discuss ongoing and future work for the MANIC project. Specifically, we discuss how to make the course material more individualized for each learner.

4.1 Making the material less like a "course"

The materials used for the first course made available via MANIC were directly adapted from pre-existing in-class materials. The current delivery of the course still retains many aspects of the traditional classroom. For example, the slides are mostly black and white; the audio for the course is focused towards an "in-class" audience; the instructor does not tell the student about the hypertext links in the on-line materials. These will change as instructors gain more experience with teaching a live class while keeping an eye towards making the materials available on the WWW via MANIC.

As noted earlier, our ability to generate material being sent to a student "on the fly" opens up the possibility of customizing MANIC material for individual student needs. Thus far, the only customization of the material is the part of the slide that is being highlighted. However, a main focus of our current work is on the use of student modeling and intelligent tutoring. From an educational standpoint, it is imperative that we incorporate more intelligent tutoring properties into the current system [Bloom 84]. One way to do this is to add quizzes which students can take on the course material. The grades from these quizzes can be used to update a "student model", which is used to track a student's abilities on the topics within the course. Furthermore, given that MANIC tracks and records every action the student takes, it knows which slides have been seen, and thus which material has already been covered. With this information, the system can tutor students by suggesting material on which they should concentrate, or even alter the material the student sees based on the student model. The tutor can also provide quizzes to the student that are at the right level of challenge. With intelligent tutoring, we can tailor the presentation of the material so that it is customized towards each individual's students likes/dislikes and abilities.

4.2 Intelligent prefetching

One way to reduce delay in network transmission is to prefetch the material that will be displayed to the user. While this is not a new idea, we intend to extend the prefetching process by using intelligence derived from the student models. The system can predict (with some uncertainty) the slides the student will be viewing next, and can download those to the client before they are explicitly requested. For example, if a student is proceeding through the course in a linear fashion, the system can detect this and send the next set of slides in the ordering.

To implement the intelligent prefetching, we are using a proxy that will work between the client's browser and the server. This proxy will be able to cache course material. When a request is made from the client, if it is in the cache, then the data does not have to be downloaded from the server. The information about exactly what to cache is determined by the server. Whenever the proxy connects to the server (which it will do even when the page is served from the cache, if only to log the user's action), the server will determine from the student model, and possibly from more general population models, what should be cached. The proxy will read this information, and will then request pages to be sent to the proxy's cache – hopefully just before they are needed by the student. The server can also send information about when to remove data from the cache. If it is unlikely a student will need to see a slide that has been cached, then it should be removed.

4.3 Annotations

The ability to make annotations on the course material is an important learning tool. The annotations can be classified into three categories: personal annotations, annotations visible to a certain group and "global" annotations. Personal annotations would be made by individual students and the text of those would be visible only to the student making the annotations. Group annotations can be made by any person in a specific group and all members of that group will have access to them. Global annotations can be used by the course instructor to clarify difficult topics. Note that the annotations can use HTML syntax and include links to other slides in the course material or to outside sites (e.g. Request for Comments (RFCs) of various networking protocols). Currently we are designing an "Annotation Server" that will support such note-taking capabilities.

5 Conclusion

We have built a simple yet flexible asynchronous distance learning environment that takes advantage of the latest advances in the computation and networking technologies. This prototype learning environment has several interesting features such as user tracking which can be used to provide individualized instructions to each student. Future work includes implementation of intelligent prefetching algorithms, building of an annotation server and creating a prototype course which can be customized for individual student's needs. We are also working on incorporating video into the available on-line course materials.

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MAKING INTERACTIVE MULTIMEDIA APPEALING TO ADULT LEARNERS

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Abstract Both students and teachers see multimedia as programmed learning revisisted, rather than a serious and long-term strategy for developing knowledge bases. This has partly come about because of a lack of formal motivational planning. This paper seeks to address this issue by identifying eight attributes of motivation and engagement and discussing a purpose-built program "*Principles of Financial Investment*" which has been implemented into the existing teaching program to determine whether students were motivated by a topic normally found to be dull and uninteresting. Formative evaluation studies conducted suggests that students found the program to be engaging, and would like to experience more interactive multimedia of this type.

INTRODUCTION

Of all the instructional media available to educators, it is interactive multimedia (IMM) which has most recently captured the attention of instructional designers, teachers and product developers. One of the reasons for this is that IMM seems to have the ability to reduce contact time between the instructor and class and provide education for mass audiences no matter where they are located. It is predicted that by the year 2000 computers will be utilised in some form in more than half of education and training delivery (Harrington, McElroy & Morrow, 1990). One problem facing adult users of IMM though, is that while there is a high degree of development of educational multimedia overall, the majority of the creative energy and money expended on IMM development is directed towards children's "edutainment" and ignores the special needs of adults. A comparison of IMM developed for children with that developed for adults reveals that developers of children's software go to great lengths to provide appealing and engaging interfaces and content, whereas developers of adult software often ignore this aspect. Many times the development is simply a matter of taking existing content and adding some multimedia elements.

At Edith Cowan University (ECU) in Western Australia, we are moving more and more to provide instructional settings for our students that recognise the value of student-centred learning environments over the more traditional teacher-centred approaches (eg. Herrington & Oliver, 1995). A key strategy in this move has been the development of IMM and other forms of computer-based learning materials. One factor of which we are continually aware, though, is the need to ensure that the materials developed meet the affective needs of the learners as well as the cognitive needs. Conventional teaching methods are very familiar to all the students and most are comfortable with them. The move to computer-based teaching and learning has the prospect to alter this comfort level. We have recognised the need to ensure that the materials we develop are appealing to the students and encourage and stimulate student use. This paper describes a project undertaken at ECU that is looking to explore factors and attributes of IMM environments which can attract and engage adult learners and can contribute to the learners' willingness to stay with a program to achieve its full learning potential.

FACTORS INFLUENCING MOTIVATION AND ENGAGEMENT

It is necessary to understand the way learners interact with IMM if the program is to be designed to motivate and engage. IMM has the ability to frequently effect changes as learners progress, moving from low level understanding through to a degree of expertise and each of these stages needs to take into account motivation and engagement. Our project has involved an extensive review of the literature describing instructional design, computer-based learning, andragogy and learner motivation. This review has revealed clear patterns between desired learner behaviour and motivation and a program which recognises this in its design is much more likely to be engaging and to lead to enhanced learning outcomes.

In general terms, the literature suggests that a motivating multimedia program tends to include experiential and exploratory features rather than the buttons and menus associated with productivity software. A motivating environment is also one which includes authentic activities and anchored instruction (eg. Laurel, 1991), is interactive, challenging and includes expert performance and guided discovery (eg. Hedberg & Harper, 1996). Our analysis and synthesis of the relevant literature suggests that there are a number of discrete factors that are important determinants and significant contributors to the development of engaging and motivating computer-based and IMM learning environments.

Immersion

As the word suggests, immersion is where the learner is completely absorbed both physically and psychologically in the program content and is a good indication of engagement (Laurel, 1991). In order to be truly engaging and allow immersion the program must be free of gender bias and provide an authentic context for learning realistic activities (see Norman, 1994; Wynn & Oliver, 1996).

Immersion is often evident in situations where games are being played. Playing is described as a flow activity—where total immersion takes place and self-consciousness and time disappear, and where the experience is so gratifying that people will undertake it for its own sake. Games are an activity which "...because of the way they are constructed, they help participants and spectators achieve an ordered state of mind that is highly enjoyable." (Csikszentmihalyi, 1993: p 72).

Reflection

Reflection is often neglected in learning environments but has been shown to be essential to learning as it encompasses elements of decision making and problem solving. Reflective skills can be broken into four parts and taught to students. First, the students do the activity themselves and gain the experience; second, they should think about the experience, what they learned, what they felt and assimilate their thoughts into a learning perspective; third, they take these new thoughts and insights and apply them to the task to get a better theory of it; and fourth, apply this new theory and get new feedback (von Wright, 1992). The role of experience in this framework is essential (Kolb, 1984) and multimedia is therefore an ideal vehicle for promoting both experience and reflection.

Flow

Play is an important part of learning, both formal and informal (Rieber, 1996), but currently play, fun, humour and enjoyment are words synonymous with computer games played by all ages. Play, or forms of it, could be an inherent part of the design of an IMM package, and has been found to be a powerful construct for interpreting meaningful learning (Rieber, 1996; Csikszentmihalyi, 1990). An important component of games or play is having flow activities which eliminate both boredom and anxiety. Flow activities lead to growth and discovery and are dynamic in that the challenge changes constantly and is at an optimal level, thus removing both the chance of boredom and the chance of anxiety (Csikszentmihalyi, 1993).

Collaboration

Collaboration can take several forms—student/student collaboration; teacher/student collaboration; expert/student collaboration or computer/student collaboration; and it is generally agreed that when using multimedia programs, motivation increases when students work collaboratively (Litchfield, 1993). This could be because the learners provide peer scaffolding and support, gives alternative perspectives, and provides a social element which increases the enjoyment of the learners.

Learner Control

Due to the disparate nature of learners, one teaching method does not fit all. (Jonassen, 1993) confirm this when they state "That learners think, process information, and learn differently is obvious. Those differences affect the courses they take and succeed in, the careers they choose, and even the friends they select…developing an awareness of how individuals differ will clarify the process of learning and the act of teaching for educators and designers in a substantial way."

Programs with more learner control are more motivating and engaging because the learner can construct their own path through the program, control the pace at which they work, and decide for themselves how much coaching or scaffolding they need (Orey & Nelson 1994).

Curiosity

All children are curious, but curiosity is not a trait fostered with adult learners. It is an important component of play and not only helps enjoyment of the learning process, but facilitates knowledge acquisition. As Malone (1980) states "One of the most important features of intrinsically motivating environments is the degree to which they can continue to arouse and then satisfy our curiosity" (p 5). To build curiosity in to an IMM program there should be elements of novelty, complexity, surprise and incongruity and these elements should not be in the form of increased information, but should surprise the learner's expectations and their existing knowledge (Berlyne, 1968). Berlyne (1968) also points out that there should be an optimal level of informational complexity for any given person at any given time, as if the material is too complex or too easy the learner will not find it interesting.

Fantasy

It is the fantasy component of a learning program which makes it interesting and intrinsically motivating (Malone, 1980). Fantasies need to be designed to accommodate the individual differences of age and gender, for example, most females do not enjoy "shoot em up" games. It is important to note that learning is enhanced only when the fantasy elements support and reinforce the learning goals of the activity (Parker & Lepper, 1992), and that the fantasy can be maintained while proficiency increases and learning goals change (Lepper & Malone, 1987). When designing educational materials based on a fantasy context, care must be taken to ensure that the goals of the learning materials and the fantasy itself are congruent with one another (Lepper & Malone, 1987).

Challenge

In order to be challenging, IMM programs need to have in-built goals. A well designed IMM will include a higher percentage of learning goals than performance goals. Learning goals encourage students to explore, initiate and pursue tasks, rather than be concerned with performance ability (Dweck, 1986). Studies have shown that learners who pursue learning goals will be motivated to produce more work and will make more active attempts to apply learning to solving new problems (eg. Dweck, 1986). Challenging, but attainable, learning goals will create more interest and enable students to sustain engagement with the task.

An IMM program for Adult Learners

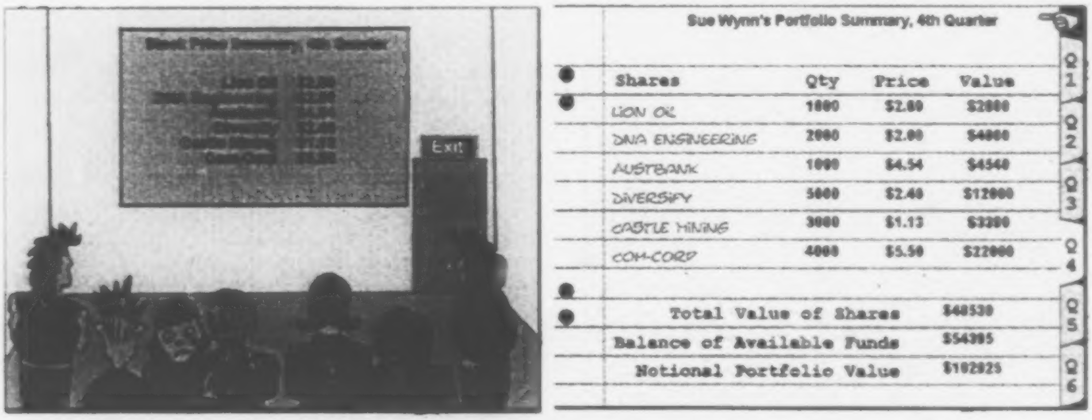
Having identified these 8 characteristics of motivation and engagement, we set about to plan a learning environment which involved each of them is some way. The learning environment which appeared to support these characteristics was a microworld. Microworlds are learning environments that simulate a small part of a real environment through which the learner can explore and discover context specific information. Papert (1980) suggests that microworlds should be simple, general, useful and syntonic—connecting new knowledge to old. We recognised that a well designed microworld should be capable of fostering motivation and engagement through these eight elements.

The learning area that was chosen to test our contentions was a course in a Business degree. A module in an introductory finance unit was targeted by the University as one where significant learning advantage could be achieved through appropriate use of IMM. This module involved teaching students about share valuation and investment. With conventional teaching learning was achieved through reading and discussion. With an IMM program, significant learning advantages seemed likely through students learning by exploration and inquiry, in their own time and at their own pace.

Principles of Finance

The IMM program that was planned to replace the conventional course was carefully designed to incorporate not only the learning sequences needed to bring about the cognitive outcomes but also to include a strong affective component.

The microworld consists of an office building called "Investment House". There is a reception area containing a help desk which can give varying degrees of hints regarding where to start and what paths to follow if the students do not enjoy browsing. Upon entering the building students are asked to register at the desk. This allows the program to be personalised and also enables them to store their data on the main computer server or hard disk if necessary. If the student tries to move on without registering a voiceover reminds them that this is a necessary step.



Sue Wynn's Portfolio Summary, 4th Quarter

Shares	Qty	Price	Value
LION OIL	1000	$2.00	$2000
DNA ENGINEERING	2000	$2.00	$4000
AUSTBANK	1000	$4.54	$4540
DIVERSIFY	5000	$2.40	$12000
CASTLE MINING	3000	$1.13	$3390
COM-CORP	4000	$5.50	$22000
Total Value of Shares			$48530
Balance of Available Funds			$54395
Notional Portfolio Value			$102925

Figure 1. Viewing room of Stock Exchange showing current quarterly share prices; and portfolio summary from the student's office desk.

There is also a blueprint of the floorplan of the building showing the other organisations within the building. These are the four main working/operating areas; the stock exchange, a stock broker, the Institute of Sound Investment and the student's office. Within these areas students can view the stock prices in a viewing room, and access their own portfolio summary from their office desk (Figure 1).

The nature of the interactions was also considered. The aim of the program was to maximise engagement and motivation, so a passive click and read type program was to be avoided at all costs. The interaction style was important as it would support the narrative intention, enhancing the participant's relationship with the product. Students should be engaged on many levels simultaneously, so it was important that the product's form, content and function should work together to create a single coherent experience communicating with the participants on a visceral level (Gould, 1995; Laurel, 1991). In this way the microworld used the principle of *form infers function* in that the design reflected the function so that the program became intuitive and the interface itself suggested to the user what it did and how it operated (Jones, 1989). Table 1 shows the 8 learner effects which we planned to incorporate and describes how each effect was built into the program.

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Learner Effect	Program Design Characteristics
Immersion	Microworld written as though the user is the person doing the investing (first person experience). The activities are all authentic and anchored to realistic, everyday principles of investment, for example, students can observe share prices in a viewing room, visit a broker to buy and sell and view their portfolio, go to the Institute to participate in theoretical courses, visit the library, and view the portfolios of "experts". Students also have their own office and can accumulate information there for perusal at their leisure.
Reflection	The interface has been designed to simulate a stock exchange building with students able to navigate through the use of a building map on the wall of each "room". Buttons and menus has been eliminated, making the program intuitive, exploratory and experiential. Students need to think about where to go next in the program and reflect on the theory when making trading decisions.
Play	Humour has been incorporated through the use of a cartoon style interface, with humorous voiceovers when students click on certain objects or try to get into the program without registering. Gaming elements are used to involve students in the process of applying theory to making investment decisions (alea), and students compete against themselves or the expert, if they wish (agon).
Collaboration	Students collaborate with the computer to acquire theoretical knowledge and then apply that knowledge to making share transactions. Students can also get feedback from expert performance built into the program. Feedback is in the form of money earned or lost.
Learner control	The learner controls the pace of learning and order of learning and the program allows the learner to discover as much as they want. There is a built in hints and tips option for learners who want some scaffolding. The built in expert performance allows the learner to model their own investment decisions.
Curiosity	Students want to explore the program to see where they can go next. Once they start investing, they become curious to see the outcomes of their investment decisions and the impact of world events on those decisions.
Fantasy	The microworld is an intrinsic fantasy (and therefore considered more effective than an extrinsic fantasy—see Malone, 1980) in that students can imagine that they are in a share trading situation, making and losing money depending on their skill levels.
Challenge	The challenge of the program is based on meeting the goals of maximising wealth. The goals are higher order in that they demonstrate competence at the activity (Dweck, 1986).

Table 1: Learner effects and their incorporation into the IMM program

RESULTS OF FORMATIVE REVIEW

A formative evaluation was conducted with Finance lecturers and an informal review with students. The rationale for the reviews was to improve the program in any way possible, measure its effectiveness in terms of ease of navigation, and ensure that all the elements worked. The students were asked four evaluation questions based on Reeves (1996):

1. What happened?
2. How can we improve the program?
3. What learning occurred?
4. Did the program make a difference?

The five students surveyed all responded positively to the first question, enjoying the process, finding the program easy to use, and wanting to use more of this style of teaching. The students also came up with a number of ways in which the program could be improved, such as improving the flow and changing some of the conventions. These have subsequently all been implemented. All students found the concepts easy to grasp and could relate the learning to the real world, and they all found that the blend of theory and practical made the material more meaningful and more interesting.

The lecturers were asked to evaluate the program in terms of comprehension, interactivity, appeal, attitude, learning (Reeves, 1996). As a result of these evaluations more substantial changes were made, including changing the development platform to Windows95 in order to improve the usability.

Further reviews are scheduled which will be reported upon fully at the conference session.

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VRML-Based 3D Topographic Maps: Enhancing Educational Applications

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Abstract: Maps are important tools in educational application. Three-dimensional topographic maps enhance understanding by providing a degree of realism unattainable in two-dimensional form. Furthermore, computer-based maps are attractive when compared to paper-based maps because they can be viewed in many different ways and because they can be stored and accessed easily. This paper presents our methodology for composing three-dimensional topographic maps in VRML, using data derived from the U.S. Geological Survey's Digital Elevation Model data. With the capability of navigation from any VRML-enabled Web browser, the maps are not only educational for map-learning primary and secondary school students, but also informative and entertaining for general users.

1. Introduction

What do maps show? For students of upper primary and secondary schools, the learning process may be enhanced by incorporating maps in a number of representations [USGS Web_b]. First, students may view an aerial-view picture of a city. This shows the region of interest but does not clearly identify the elements of that region (e.g., street names and political boundaries). Next, the students may examine a shaded relief map of the city's surroundings, including the shapes of mountains, valleys, etc. This provides a presentation of the area with moderate abstraction. Even more abstractly, students may be given a road map of the area; it may be difficult to get a good sense of the "landscape" from this map. Finally, topographic maps or terrain models, which involve many abstract notions such as contour lines, can be shown to the students.

Among these map styles, topographic maps are the most self-explaining way to make clear the correspondence of physical and man-made characteristics of locations [USGS Web_b]. However, topographic maps are printed on paper and hence present a two-dimensional encoding of our three-dimensional (3D) world limited to viewing from a fixed viewpoint from above. Consequently they do not provide an immediately intuitive representation of physical terrain.

To bridge the gap of non-intuition, we present 3D topographic maps and methodology for creating the maps in this paper. The 3D maps are encoded into the Virtual Reality Modeling Language (VRML), version 2.0 [Hartman & Wernecke 1996], and are based on "truthful data" derived from the U.S. Geological Survey's (USGS) Digital Elevation Models (DEM). The USGS is a bureau of the U.S. Department of the Interior and their models are freely available from their Web site [USGS Web_a]. With any VRML-enabled Web browser [SDSC Web] [SGI Web], users are able to freely navigate around the 3D maps, or 3D terrain, changing position and orientation of their viewpoints to observe the ups and downs of the topography.

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Traditional color topographic maps have only a few colors applied, so terrain is divided into a number of ranges with clear-cut boundaries. Our 3D maps are colored continuously: every elevation is associated with a distinct color, that is, colors vary when there are elevation changes. Consequently, whenever colors are appropriately selected and proper DEM data are given, the 3D maps turn out to be highly informative, showing many additional details of topography, when displayed on high-resolution, true-color computer monitors.

We also have added markers to the map to pin-point the location of major cities on the 3D maps. These markers, shown as small blue cones, are positioned using location information available from the Census Bureau's Web site [US Census Web_b], and are hypertextually linked to other sites that give relevant information.

In the following section we will show an extended example of map browsing in our implementation. We will then give detailed information about how the maps are formed.

2. Terrain Navigation

As illustration we consider a hypothetical high school geography class located in Montgomery County, Maryland, where students are studying the land forms of their region. The students have access to the Internet from personal computers in their classroom, and are examining topographical data over the Web. The teacher has introduced the color-elevation relationship and the students have linked to a Web site storing VRML-based 3D topographic maps. Under the teacher's guidance, a 3D map for the National Capital surroundings as in [Fig. 1] is brought up.

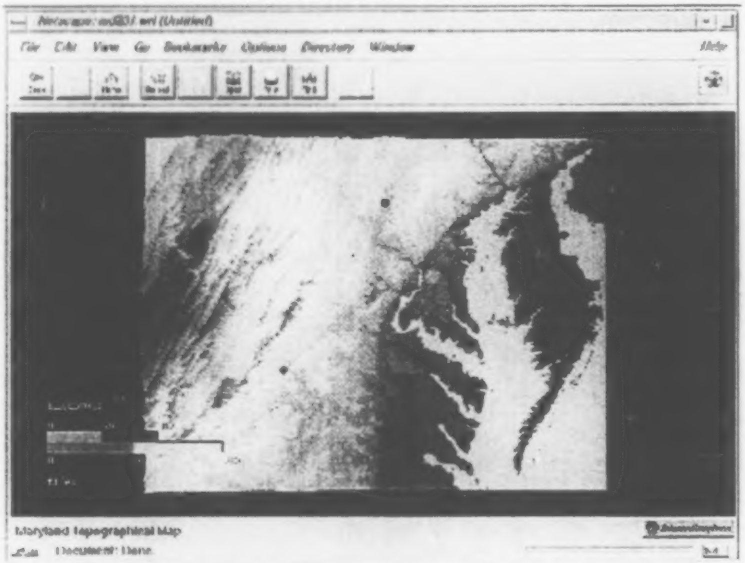

Figure 1: Areas surrounding Washington, D.C.

At first sight this is a traditional topographic map but with smooth color changes over elevation changes. However, if the map is manipulated to move the viewpoint repeatedly, things are much different. For example, viewing from the right of the map, a big bay, Chesapeake Bay, can be seen as in [Fig. 2], which is in the same map as in [Fig. 1] but from a different viewpoint.

From that viewpoint, an arc-shaped contour line looks clear, which encloses low land areas near the bay and big river channels such as the Potomac River in the center. Viewpoint changing, or navigation, is just like viewing from an airplane: Not only can the airplane fly in any direction, but also it can pitch, yaw, and roll. In addition, there are a number of indicators (blue cones on the map) to hypertextually link the locations of major cities (at the tips of cones) to city information on the Web to enhance readability of the map.

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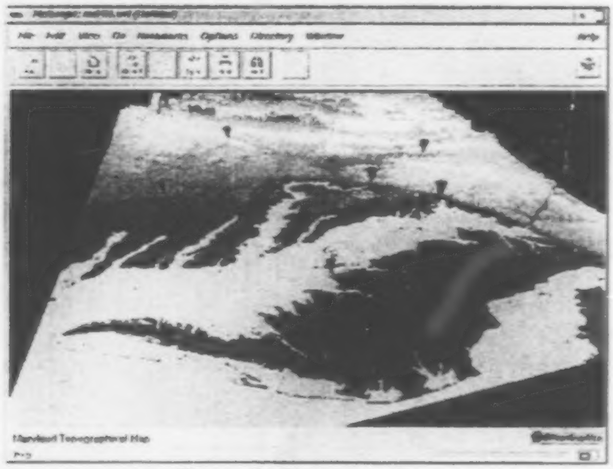
File Edit View Go Bookmarks Options Directory Window Help
Maryland Topographical Map

Figure 2: Chesapeake Bay

The airplane can fly further towards the west crossing plains and entering the first mountains en route. This is the Blue Ridge Mountains. A new viewpoint appears as in [Fig. 3]: with the Blue Ridge on the right, the Shenandoah Valley in the center, and the Appalachian Mountains on the left. From the map the teacher can explain to the students the reason for the beautiful scenery of Skyline Drive (built on the ridge of Blue Ridge Mountains), where they had a field trip earlier. Furthermore, since the valley looks very flat here, the construction of Interstate Highway 81 can be justified.

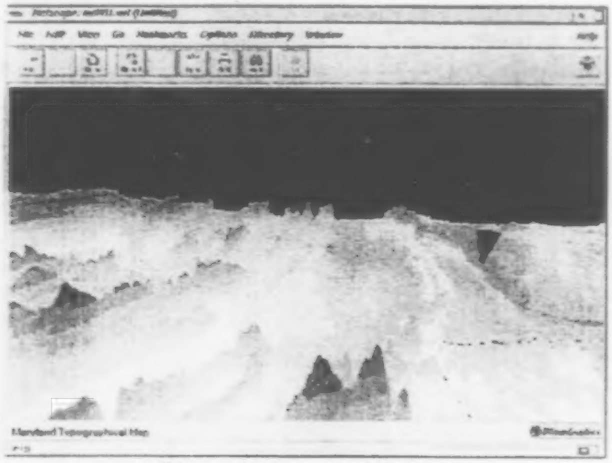
File Edit View Go Bookmarks Options Directory Window Help
Maryland Topographical Map

Figure 3: Shenandoah Valley

3. Issues of Map Making

3.1 Resources on the Web

The basis for our map making is the extraction of elevation data from DEM data, which are available from USGS Geo Data Web site [USGS Web_a]. The DEM data that we used are called 1-degree DEMs, where each file of a DEM is in plain text with latitude and longitude information plus 1,200 x 1,200 elevation data points for each 1-degree-by-1-degree block within the whole continental United States. In other words, one elevation data point is given (in terms of an integer in unit of meters) for every 3 arc second along a meridian (which is 93 meters or 300 feet [Pearson 1990]) by 3 arc second along a parallel (which is 300 feet times the cosine of the latitude at that point). The size of a gzip-compressed DEM file mostly ranges from 0.5 MB to 1.5 MB.

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The data with a resolution of 1 arc second (30 meters or 100 feet) by 1 arc second also are available from the USGS if more detailed data are needed. The size of this DEM is about 9 times that of a 1-degree DEM. Since we do not plan to compose 3D maps of such detail, the 1-degree DEM is enough to serve our purpose in consideration of storage efficiency.

Another useful resource is the U.S. Census Bureau's Gazetteer [US Census Web_a], which provides census data for all U.S. cities including their latitudes and longitudes. Based on the information, small blue cones were displayed in the current implementation to pin-point city locations.

3.2 Contour Lines Coloring

There are many ways of color drawing in 3D maps. In the current implementation, each elevation is associated with a different color. More specifically, eight major colors are picked to associate with eight pre-selected elevations (See [Tab. 1]). Then, any non-pre-selected elevation is associated with a color linearly interpolated in RGB space between two major colors such that the elevation is between the associated elevations of those two colors. Based on this color scheme, nearby elevations have similar colors. Our color scheme reflects more change in lower elevations than that in higher elevations since in general more locations are at lower elevations than at higher elevations.

Meters	**Feet**	**Red**	**Green**	**Blue**	**Color**
8000	26247	1	1	1	white
2500	8202	0.1	0	0	dark wood
1500	4921	0.5	0	0	wood
1000	3281	1	0	0	red
500	1640	1	0.5	0	orange
250	820	1	1	0	yellow
100	328	0	1	0	green
1	3	0	0.3	0	dark green

Table 1: Land elevation (Linear interpolation of colors is performed in RGB space.)

3.3 Map Projection in VRML

Since the data of each DEM are uniformly distributed in a square grid under the latitude and longitude coordinate system, it is natural to pick the ElevationGrid node in VRML as building blocks for 3D maps. That is, our map projection is a kind of Mercator projection [Pearson 1990]. Under this projection, the distance relationship is preserved in meridians; the length of a degree in a parallel is proportional to the cosine of the latitude at that point. Unfortunately the ElevationGrid node is a rectangular grid without the above attributes. For a map covering a large area, the latitude difference between the top and the bottom of the map are small and can be ignored. For a map covering a small area, the latitude difference is relatively large and should be considered.

For simplicity, a parallel near the center of a map was picked to approximate the scale of all parallels in the map. That is, in 3D maps the ratio of the length of 1 degree in any parallel to that of 1 degree in any meridian is fixed, which is the cosine of the latitude of the central parallel.

3.4 Elevation Exaggeration

Except for steep mountains and valleys, the 3D topographic maps with truthful elevation data are usually very flat and not distinctive if the vertical and horizontal distances are at the same scale. For this reason, map elevations are commonly exaggerated to draw attention to changes in the 3D terrain. This rule applies to our 3D maps, too.

3.5 Boundary Lines Cutting

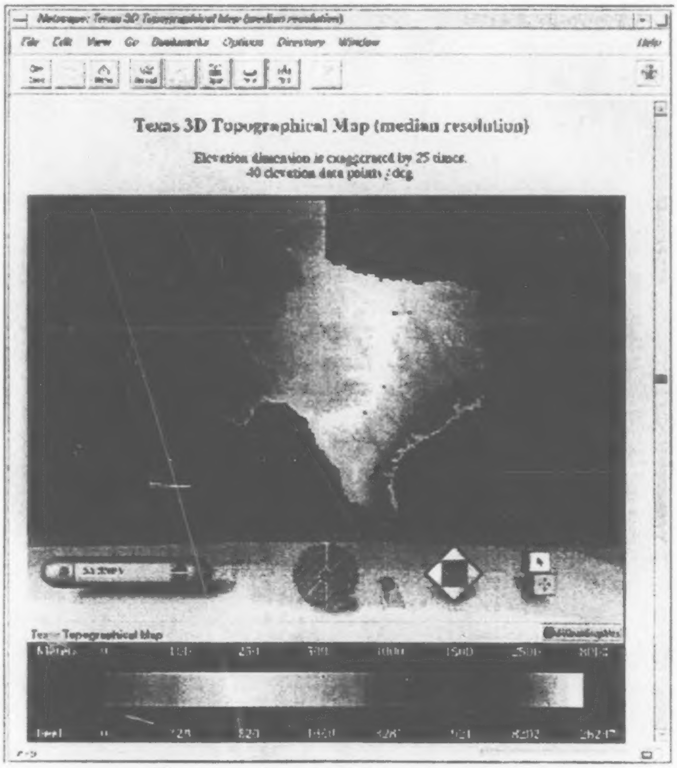
Since the DEMs are always in 1-degree-by-1-degree blocks, there is no boundary information such as state or county lines carried in the DEMs. Digital Line Graphs (DLG) from the USGS Geo Data Web site [USGS Web_a] can serve this purpose. However, due to the limited time available for this implementation and the fact that the DLG data were digitized from physical maps, we selected to "digitize" the borderlines we needed from a printed map with pencil and paper. Every ElevationGrid node involved with borderlines has been replaced with a group of smaller ElevationGrid nodes that approximate the lines. This is a divide-and-conquer approach.

3.6 Elevation of Zero

Since the DEMs do not distinguish the water bodies from the land, we cannot tell the ocean from the coast because elevations below 0.5 meter are rounded to zero in the DEMs. In the current implementation, the elevation of zero is treated as the ocean and is colored in blue. Therefore, some low lands are inevitably "washed out" in our maps. Accurate coastal lines are required to offset this problem.

4. Implementation

Two state maps were composed to prove the concept of methodology: Maryland without border trimming (see [Fig. 1]), and Texas with border trimming (see [Fig. 4]). Also, two assistant scales were included: a color bar chart for land elevation and a mileage scale. There were 15 DEMs in total employed for the Maryland maps; 82 for the Texas maps (among them, 33 involved with the trimming process where each was split into ten long strips to approximate the Texas state line that was manually delineated from a physical map [USGS 1967]). All of the maps are exaggerated in the elevation dimension by about 20 times.



Texas 3D Topographical Map (median resolution)

Elevation dimension is exaggerated by 25 times.
40 elevation data points / deg

Figure 4: Texas 3D Topographic Map

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For the issue of map projection, the 31-degree parallel, which is about equally distant from Houston and Dallas, was picked as the central parallel for the Texas maps (the ratio is 0.857); the 38.5-degree parallel was chosen for Maryland (the ratio is 0.7826).

With a resolution of 1,200 data points per degree, the 1-degree DEMs afford enough details for almost all small and large scales of US topographic maps. However, considering the resolutions of computer monitors and various processing powers of machines, we decided to deliver maps with 3 kinds of resolutions: a low resolution at 10 x 10 points per 1-degree-by-1-degree block, a median at 40 x 40 points, and a high resolution at 200 x 200 points. All data sets were uniformly sampled from the DEM data.

Since the location of a city in the maps is 3D, three coordinates are needed. Besides the latitude and longitude information from the Census Bureau, the elevation coordinate is selected to be the elevation of the most adjacent point in the DEM data. Then, the three coordinates are transformed into a proper VRML coordinate system to pin-point a city.

Some efforts were made to shrink the sizes of VRML files to reduce downloading time, such as dropping unnecessary zeros before decimal points, deleting unnecessary spaces, limiting RGB values to two-digit decimals (since human eyes may not be able to tell more than that), and finally compressing VRML files.

5. Future Work and Conclusion

Currently our 3D maps do not deliver information about rivers, lakes, highways, and land use, which can be built in the future based on USGS DLG data. We are considering incorporating user-specified modifications to the color scheme and the overlaying of satellite images or weather information for visualization purposes. In VRML 2.0, sensor nodes can send out events containing the 3D coordinates of points clicked by the mouse. This provides the basis for carrying out a 3D counterpart of the clickable imagemap on the Web. Based on this idea, a 3D topographic mapping service similar to Census Bureau's TIGER Mapping Service [US Census Web_a] can be accomplished in the future.

Our 3D map implementation can be viewed on the Web at http://www.csdl.tamu.edu/topomaps/.

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Intelligent Agents for Teaching People How To Cooperate

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Abstract

Various systems have demonstrated the effectiveness of intelligent agents in a number of different applications. Agent technology that supports groups of users located in different geographical areas has been scarcer. Our intention is to create software that is designed to adapt to a group's needs by offering a variety of help and support when required. In order to accomplish this goal, we built a series of advisory-style agents that support group planning activities. The agents access an adaptive group model that contains information about the group's plan, activities, and expertise. AI reasoning techniques are used to match the help to the needs of the group. This help comes in the form of text and examples. Thus, the system attempts to provide instruction to groups on how to work together to improve the planning activity.

1 Research Objectives

As the information superhighway continues to grow, we are being forced to re-examine the way people work. The idea of the "office worker" is gradually being replaced by a simple connection to e-mail that makes it possible to have rapid and frequent interaction with people throughout the world [Whitaker, Frohlich & Daly-Jones 94]. Yet, in spite of this rapid growth in telecommunications, most network applications continue to favor individual rather than group work. Our intention is to fill this gap by creating a series of applications that contain advisory-style agents that can facilitate groups of people working together over a distributed network. The specific context for this work is programmers engaged in planning a large programming project. The advisory agents are able to detect ineffective collaboration and provide groups with information about how to improve their activities. Furthermore, the agents can initiate communication, monitor events, perform tasks, and aid in collaboration with other workers. The metaphor for such a system is a coach who encourages his/her players to work together as a team. Our vision is to create a "coaching" system that provides a method of mentoring groups through electronic means.

2 Related Literature

Much has been accomplished already in demonstrating the potential of using agent software in combination with various network software products for communicating and seeking information [Barron et. al. 94] [Maes 94]. For example, there are systems that incorporate information from different sources [Gruber 91]; ones that search for loosely specified articles from a range of document repositories [Voorhees 94]; And, still others that allow heterogeneous database systems to work together to answer queries [Hughs el. al.]. Missing, however, is the development of agent software that exhibits clear advantages to working over the network as a member of a team. While we know that network technology can be used to empower individuals with the latest information, we also know that it lacks the in-depth contact among small groups of workers that is at the heart of every corporation [Whitaker, Frohlich & Daly-Jones 94]. Thus, our prototypes and models must clearly demonstrate how network technology can evolve into an ecosystem of information, communication, and innovative mentoring that supports not only individuals but groups of people working together.

In order to address this problem, the authors engaged in a number of innovative group software projects sponsored by various funding agencies over the past several years [Swigger, Brazile & Shin 95] [Swigger & Brazile 95]. In order to enhance a group's understanding of various activities (e.g. library database searching, requirements elicitation, and cost center analysis), the authors built several computer-supported cooperative interfaces that facilitate cooperation. Groups learn to become more effective collaborators by using specially designed computer tools that enable them to organize and systematize their interactions. The cooperative interfaces rely on a shared window system (i.e., What you see is what I see) that allows groups who are geographically distanced from one another to execute controlled tools in shared windows. The systems have been implemented using C++ on a number of different platforms, all connected to a local area network. The interfaces themselves consist of a series of online tools designed to support specific group competencies deemed important to effective group communication. Results from studies that compared groups who used the experimental cooperative environments versus those who performed the same tasks face-to-face indicate that the systems are able to improve task performance [Swigger & Brazile 95]. This interaction was significant when a t-test was computed on these data ($F=5.66; p < .001$). More importantly, the software has been recently transferred to several real-world environments and is currently being used by companies involved in another NSF project investigating team effectiveness.

While the above groupware seems effective in supporting collaborative work, it lacks the coaching capabilities that enable participants to *improve* their collaborative skills. After much discussion, it was determined that a set of advisory style agents might help groups with their initial planning tasks as well as assist them in resolving conflicts that occur as a project progresses. In order to meet this need, we built a series of coaching agents that support these two functions. The agents are designed to detect ineffective collaboration among groups and provide them with information on how to improve their activities. A second series of agents help monitor the work flow and help negotiate new planning tasks. A more long-term goal of the project, however, is to develop a new metaphor for working; one that embraces the idea of collaboration. We would like to move users from their specialized environments into a shared, multi-user setting where diverse groups within an organization can collectively solve problems.

3 The System Overview

Using the techniques developed in the previous research, we built a special interface that encourages participants to cooperate more effectively. The specific context for this application is ‘project planning,’ specifically project planning as it relates to the software design process. The idea is to create a collaborative system that helps groups of programmers with various planning tasks associated with the software design process. The specific coaching agents embedded within the application are designed to help programmers do the initial planning as well as resolve conflicts that occur after the plan has been created.

The collaborative planning software is highly interactive, allowing groups to access the interface and plan and schedule tasks. Moreover, the system supports users who are located in different geographical areas, but who need access to the same planning information *at the same time*. Users are free to use the interface to organize their planning tasks in an effective way. A typical sequence of planning tasks includes: entering the goals for the project; entering the individual tasks required for project completion; voting on tasks priorities; assigning individual members of the team to each task; monitoring the tasks after the project begins, etc. For each activity there are a set of coaching agents that help groups manage and organize that specific activities. For example, the ‘agenda’ task includes a set of agents that help set and manage conflicts among agenda items. Similarly, the scheduling task is supported by an agent that resolves scheduling conflicts.

3.1 The System Components

The specific components of the system include: a) A special collaborative planning interface, b) The “agent” software designed to help groups with planning activities, and c) The support programs that manage the communications and database functions. The special planning interface was developed using Groupkit, an applications development package designed by researchers at the University of Calgary [Roseman & Greensberg 96]. Groupkit is a series of software modules that help developers create and integrate special purpose tools that support collaborative activities such as brainstorming, white boards, group management systems, etc. Although the interface was generated with the help of Groupkit, the specific system is designed as a client/server architecture whereby items are stored in a database on the server and may be viewed independently by the various members of the group. Client processes interact with users, gather information, and request the server whenever they need to access the shared database that records the information on groups, members, and agenda items. The server process manages the object-oriented database and interacts with the client processes through a Groupkit environment. [Fig. 1] shows the overall architecture of the shared data access and the database management system.

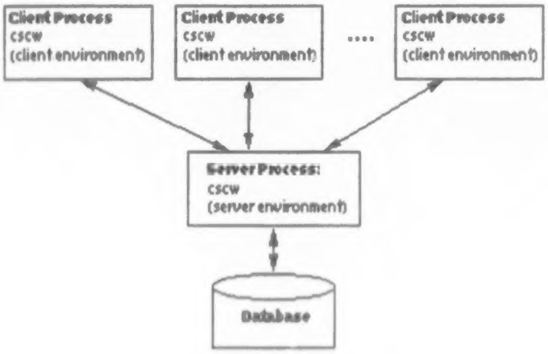


Figure 1: Client/Server Environments for Shared Data Access

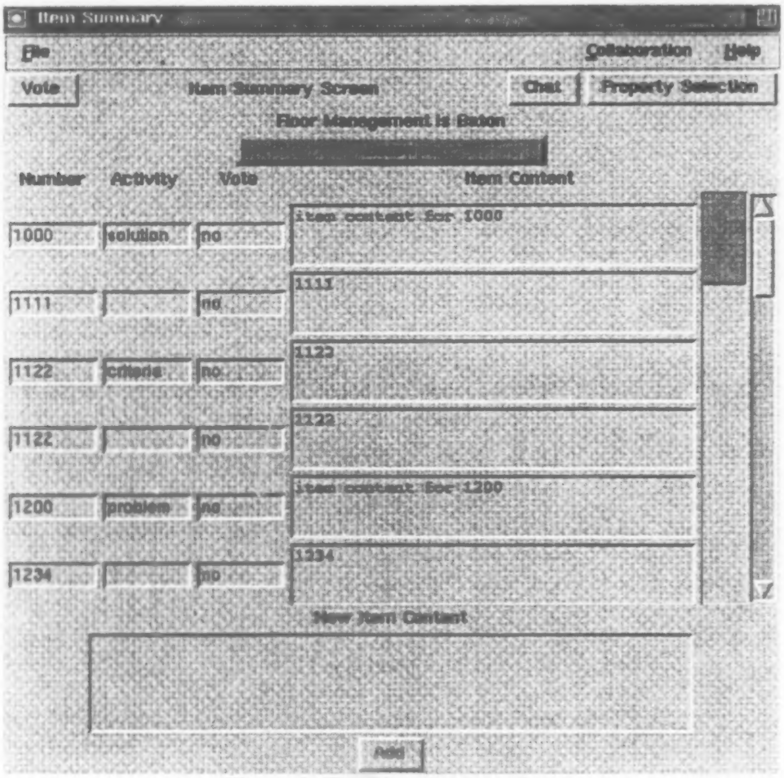
3.2 The Collaborative Planning Software

The planning interface consists of various columns and rows that can be configured according to the user's needs. The users can alter the interface by simply changing or adjusting various properties. The interface itself allows users to enter items, give priority to items, vote on items, sort items, and identify the author of item, date it was created, etc. (see [Fig. 2]). There is no fixed way the groups interact with the software. Rather, groups are free to select among several different types of floor management styles including: 1) Director (i.e., a single person selects who and when members interact with the system); 2) Baton passing (i.e., the person who currently controls the system selects the next person to interact with the system), and 3) All-at-once (i.e., everyone is free to interact with the system at any time). Based upon which floor management style is selected, members can enter, view, and change any information on the screen.

All information entered on the screen is then stored in the system as an item or a part of item. As a result, items can be deleted, re-sequenced, displayed, etc. Other attributes associated with items include time and date created, author, priority, and type of activity. The latter attribute is assigned by the system and is used by the agent intervention software to make decisions about when to interact with the users (see below). Each member's transactions are also stored in the database and used by the agent intervention software. A more detailed explanation of the agent software now follows.

3.3 The Coaching Agents

As previously mentioned, the special planning software has the "instructional" goal of assisting groups with collaborative skills. The system accomplishes this goal by invoking a series of coaching agents that intervene and offer advice whenever they detect ineffective collaboration. In our previous research, we found that groups can improve their group's performance if they use effective collaborative skills. The skills found to be most predictive of effective cooperative problem solving include those that support problem orientation, help establish criteria, assist in establishing correct operating procedures, help generate alternative solutions, and facilitate the evaluation of the solution [Swigger, Brazile & Shin 95]. We believe that these same cooperative skills can be to help groups plan more effectively. Thus, each of the items in our interface (see above) has been assigned an activity attribute that corresponds to one of the skills that leads to more effective group performance. For example, whenever a group changes an item, the system records an activity attribute that indicates that the fourth skill (i.e., generation of alternative solutions) is being exercised. Similarly, whenever the group votes on an item, the system records that the skill of "evaluating the solution" has been performed.



Number	Activity	Vote	Item Content
1000	solution	no	item content for 1000
1111		no	1111
1122	criteria	no	1122
1122		no	1222
1200	problem	no	item content for 1200
1234		no	1234

Figure 2: The Planning Interface

The system's coaching agents have been grouped as either those that run on the server and monitor activities related to the entire group (i.e., Group Agents), or those that run on the client and monitor individual actions (i.e., Member Agents). For example, Group Agents determine whether an item has been voted on, an item has been changed and updated, or an issue decided, etc. On the other hand, Member Agents watch whether a particular member of the group has participated in the discussion or made a statement, etc. All the activities of the Group Agents are handled through a Master Event Handler that is responsible for placing the requests on a queue, activating those requests, and re-directing information. Member Agent activities are handled in the client workspace, but can be sent to the Master Event Handler for additional processing.

Individual agents are then created by defining 1) a set of statistics that can be used to determine intervention (in the form of an SQL request to the database), 2) the event(s) that will trigger the intervention (in the form of a rule), 3) the specific content of the intervention message, and 4) the location(s) of the intervention message. Thus, each agent can be designed to look for evidence of good and poor behaviors, and then coach group members to become more effective in a particular area. Since all the information is stored in the database, the coaching agents can ask for specific data that allow them to recognize a sequence of effective and ineffective behaviors. Because the items are associated with a particular competency, the coaching agents can intervene whenever the group is demonstrating ineffective behavior (see [Fig. 3]).

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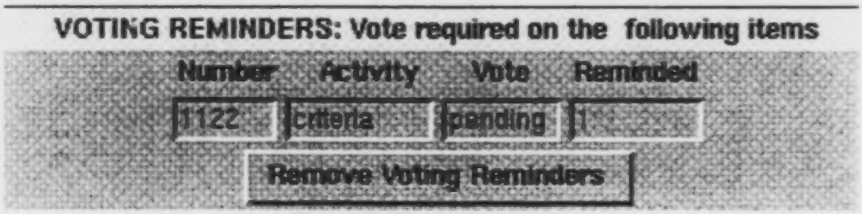
VOTING REMINDERS: Vote required on the following items

Number	Activity	Vote	Reminded
1122	criteria	pending	1

Figure 3: The Voting Agent

4 Current and Future Directions

We are currently evaluating the effectiveness of the system. The major questions that we wish to ask are: To what extent are the advisory agents effective? What are the benefits of using the advisory agents over other techniques? These questions will be answered by examining the data recorded by the coaching system and comparing it with groups who do not use the software. For example, output from groups using the coaching agent software will be compared to the output from groups who engage in these planning activities without the advise. We believe that those groups who use the cooperative environment will have significantly more user satisfaction and higher "performance" than student groups who do the same task face-to-face.

We are also constructing a second model of group intervention that concentrates on the runtime portion of the planner. Once a project is underway, it is important for groups to be able to modify plans and engage in iterative processes that involve the generation and refinement of ideas and solutions. A coaching agent that can detect problems in the plan, notify members of potential problems, and encourage groups to pursue different alternatives should facilitate this particular competency.

Since a group identifies group/task relationships while creating an initial plan, coaching agents can be built that use previous information to notify specific members about potential conflicts that might occur after the project has started. Potential conflicts can occur if a member fails to complete a scheduled task, an objective changes or is altered, or a task is no longer valid. The system will "advise" specific members or the entire group to re-visit their objectives to determine whether modifications should be made. Since our previous research has indicated that group effectiveness is related to an ability to generate alternatives, we intend to design special cooperative tools that help facilitate the re-planning task. Again, special evaluation tools will be available to the participant for re-scheduling tasks as well as resolving conflicts.

5 Conclusions and Impact of Research

In conclusion, we believe that we have identified a situation for which there is a definite need for computer assistance: *A system that will teach groups how to work together*. We then described a plan for providing such a system. We explained how we have developed a prototype interface that allows us to track activities of groups using the collaborative software. We also described how we have designed a series of coaching agents that intervene whenever they detect ineffective collaborative behaviors.

In previous research, the authors found that it was possible to design an interface that could facilitate cooperation among groups [Swigger, Brazile & Shin 95] [Swigger & Brazile 95]. They also observed that it is possible to assess group performance by evaluating effective group skills through the use of particular competencies or skills. Thus, our goal is to use these results for developing broad-based systems that can be used in designing different types of collaborative software. It has been our observation that the need for cooperative skills occurs frequently in this technological society. Yet rarely do we help people develop these skills. As such, this research should provide insight and software tools to achieve this goal. Moreover, it will provide a rich environment that will allow us to investigate various issues related to helping people work together.

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ELECTRONIC AUDIO-GRAPHIC TUTORIALS: A TEACHER'S PERSPECTIVE

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Abstract: In its development of systems that exploit the Internet to support distance education, the Open University recently presented its first audio-graphic tutorial to a group of geographically remote students. This paper describes the benefits of audio-graphic tuition when compared with the more common use of electronic computer conferencing from the perspective of the teacher, and reports on the effectiveness of this mechanism for teaching. The paper also describes strategies and tactics that were found to be useful for teaching in this medium.

Introduction

This paper reports on the latest in a series of trials aimed at determining how electronic teaching can be used to replace or supplement conventional (face-to-face) teaching sessions (tutorials) [Thomas et al. 1996]. Our approach is to compare and contrast conventional teaching systems with Internet teaching through a series of large scale controlled experiments. Because this is a new field of activity, not only do we have to perform controlled experiments but also we have to develop teaching techniques which exploit the new technologies. In this paper we examine the advantages and disadvantages of using audio and graphic communication over other forms of electronic teaching such as computer mediated conferencing. Of particular interest is how well the technology enables us to reach out to geographically remote students to support their learning when distance prevents them from taking advantage of conventional face-to-face sessions. We are also concerned to provide technological solutions which are low cost in order that the techniques that we develop can be applied to distance teaching on a large scale (thousands of students on each of hundreds of courses).

Experience of electronic tuition at the Open University

A major problem that a distance education institution faces is how to reach out to students in geographically remote areas. In addition to high quality teaching materials (a combination of printed materials, video and audio cassettes, TV and radio transmissions, and computer software), the Open University also provides tutorial and counselling support to its students. Each student is allocated to an academic teacher (known as a tutor) who typically provides a small number of face-to-face teaching sessions (tutorials: similar to conventional seminars) and offers help on an individual basis via the telephone. This system works well in high population density urban areas where it is economic to hold tutorials. However, for remote students, travelling long distances at inconvenient times to a tutorial can be a significant barrier to learning; see also [Jones 1996]. It is clear that electronic communication with students in their home using the Internet has the potential to bridge the distance gap for remote students.

In 1995, a trial was held using the Internet to teach approximately 30 students resident outside the UK who were studying an introductory course in computing [Price & Petre 1996]. The Internet was used for tutor-student communications and included electronic submission of tutor marked assignments and answering student queries. The trial was sufficiently successful for it to be extended in 1996 to two courses with approximately 250 students and 25 tutors. This time, the majority of students were UK based but included students from Continental Western Europe, USA, Malaysia, and New Zealand. The success of the 1996 trials [Carswell 1996] have encouraged us to increase further the scale of tutorial provision in 1997 to over 500 students on 5 courses (not all of which are computing courses. Our objective is to improve and enhance the system in readiness for a new computing course to be presented in 1998 for which all of its projected four thousand students will be tutored electronically.

In our 1996 trials, we investigated primarily asynchronous electronic tutorials in which a conferencing system was used to support tutor-student, student-student and tutor-tutor interaction. A typical tutorial began with the tutor posing a problem and asking students to respond by posting their views on the conference. The tutor's role was to encourage all students to think about the problem and to react to other students' postings. In this way, over a short period of time (typically a week), a consensus of opinion about the problem and its solution was developed. (This is only one of several models pioneered in the 1996 trials). The advantages of asynchronous working [Steeples et al. 1996] are:

(i) low connect time (students typically use slow modems which, for synchronous tutorials, can incur high telephone charges);

(ii) more time for reflection (performed off-line) resulting in better responses to questions;

(iii) allows for time differences across the world;

(iv) enables students to participate at times of their own choosing to fit in with their personal life-styles.

Although asynchronous communication is an enabling technology, pedagogically it has the serious disadvantage that responses to student queries are not immediate as would be the case with synchronous tutorials. For this reason we investigated alternative technologies to see how they could improve the students' learning experience. For example, compressed video [Miller 1996] is extremely attractive but is extremely expensive and not at all suited to mass distance education. Interactive Remote Instruction using high speed networks and high performance workstations [Maly et al. 1996] are also very expensive and are more suited to remote classroom use. Nevertheless, some of the experiences in using these systems for distance education are applicable in our context. We required a low cost technology that could be easily set-up by students in their own homes and which could be managed easily by the tutor (also working at home). A useful summary of related work can be found in [Watabe et al. 1995] where collaborative work over the Internet is discussed.

Audio-graphic tutorials

In the Open University teaching system the tutorial plays an extremely important role:

- to overcome the isolation of the long-distance learner;
- to encourage the exchange of ideas and learning experiences;
- to enhance the delivery of distance learning materials in a structured and supportive environment.

Therefore, any electronic tutorial must meet the same general objectives, although it is clear that the student experience will be quite different depending on the delivery medium used. It is also important to note that the tutorials in this model consist of essentially small to medium sized groups (maximum 25 students, but in practise about half this number attend).

Synchronous computer conferences are well established and can be fruitfully exploited for tutorial purposes. However, the low bandwidth of keyboard communication can make synchronous tutorials rather tedious resulting in low amounts of information exchange particularly when compared to a face-to-face tutorial. The use of audio and graphical channels improves the communication bandwidth significantly.

Therefore, we have developed an audio-graphic tutorial in which the tutor communicates with a group of students over the Internet using a voice channel and a graphics interface (a whiteboard). With this technology the tutor is able to send graphical information with synchronised voice communication in such a way that students can see the graphics on their own computer screen and hear a simultaneous commentary from the tutor. In turn, the students can communicate with the tutor and other students in the group. In the trial reported on here, students

1060

were restricted to communicating via their keyboards. Although the audio channel could have been used by students for transmission, we wanted to concentrate on the educational aspects of the system and therefore reduced the number of possible problems that could arise with simultaneous broadcasts from all students in the group.

There are several approaches to the effective exploitation of audio-graphics:

(a) A lecture-style presentation, in which the tutor presents information to remote students in the form of a commentary over textual and graphical information. If performed live, this is a pedagogically inferior mechanism to traditional TV transmission or video. Its advantages lie in the fact that the tutor can react quickly to student queries by "broadcasting" answers relatively soon after the queries have been received. That is, students submit questions in advance and the tutor prepares responses prior to the broadcast. The responses could be prepared "off-line" and be stored for transmission at the allotted time. However, the fact that the medium permits the real-time construction of graphical and textual information combined with an audio commentary on what is happening is an important step forward over an asynchronous computer conference.

(b) A tutorial-style presentation, in which the student can react immediately to the material being presented. Immediate feedback to the tutor is the essential feature of this mode of working. Students can ask questions about the material to obtain immediate clarification. Thus, there is real-time interaction between tutor and students.

(c) A group activity, in which all members of the group interact in real time to solve a problem and where the tutor's role is to help, encourage and focus the activities of the group.

The Trial

The trial consisted of a group of students and a single tutor. The students were located in their own homes using conventional medium sized PCs. The tutor was located in the Audio Visual Department at the Open University where devices such as video cameras were available for recording the session. The students were volunteers currently studying a third level computing course which had been presented electronically throughout the 1996 academic year. Therefore, all participants were geographically remote from each other but had been in contact using e-mail throughout the course. The tutor was an experienced distance education tutor who had been teaching on the electronic course. The audio-graphic tutorial was the last tutorial of the course and immediately preceded the end of course examination. In the following description, only the tutorial aspects of the trial will be discussed; ensuring that the students were able to set-up and use the software is not covered here, although this proved not to be a problem.

In our trial we used WhitePine's Enhanced Cu-SeeMe (V2.0.1) for the graphics (the whiteboard) and Progressive Networks' RealAudio (V2.0) for the voice channel running over the Internet.

Arrangements for the audio-graphic tutorial began well before the actual date of the transmission (5th October 1996). The first task was to e-mail the students to say, in brief, what was going to happen in the tutorial by giving a brief summary of the mechanism and the date and time it was to take place.

About ten days prior to the tutorial, a follow-up e-mail was sent which described precisely what was going to be covered in the tutorial, that is, a past exam question would be worked through for revision purposes. Students were sent the exam question to read and asked to respond (by e-mail) requesting specific topics to be discussed in the tutorial. The information returned by students enabled the tutor to focus attention on certain aspects of the question and prepare, in advance, computer files of information that could be readily placed on the whiteboard during the tutorial.
Shortly before the specified start time of the tutorial, both sound and vision were transmitted to inform students that they had connected through successfully. This was a simple "welcome screen" together with voice-over.

The first part of the session proper was devoted to "social interaction". That is, a video picture of the tutor was transmitted (this was the first time that many of the students would have had sight of the tutor). It has been found in previous trials that an initial socialising period helps the group settle down, and ensures that attention focuses on the task in hand without becoming too concerned about the technology. This period enabled students to send welcome messages to each other as they logged on.

The tutor spent the next part of the formal activities talking about what the session was about and how the students were expected to interact. The main teaching began with a reading of the exam question, and the tutor answering the first part. This was a fairly simple step, covered reasonably quickly so that students could settle in and begin thinking about the question. The technique for interaction consisted of the tutor taking short pauses from the dialogue and giving the students direct and explicit instruction to type in any comments or queries they may have on the material dealt with so far. Most of the time the instructions were given both textually and verbally to ensure that students fully understood what was expected of them.

Having obtained a student response (e.g. the answer to a part of the question, or the next step in an argument) the tutor commented upon it. For most of the time, student responses were generally correct and the tutor simply posted the answer on the whiteboard as a record of the interaction thus far. When a response was incorrect or inappropriate it gave the tutor an opportunity for comment.

A significant issue arose: it was often the case that it was the "better" students who responded first so that not only were the responses correct, it meant that some students did not bother to respond. This situation is not unknown in the classroom, and it is up to the tutor to control the situation to enable all students to participate. More work needs to be done in this area to develop techniques and tactics suited to audio-graphic tutorials.

The tutorial lasted for approximately an hour and a half, and was concluded with the tutor summarising what had happened, thanking the students for taking part and reminding them to provide immediate feedback to the evaluation team via a questionnaire that had been sent by e-mail just before the tutorial.

Evaluation

In order to evaluate the trial the following records were kept:

- a video recording of the tutor's activities
- a video recording of the tutor's screen
- a video recording of a student's screen (we set up a video camera in a student's home)
- an audio record of the trial
- documents relating to the pre-trial set-up
- responses to a student questionnaire (given immediately after the session)
- a tutor de-briefing
- a technical de-briefing
- debriefing interviews with students

At the time of writing, all of our data records had not been analysed in full, but the initial feedback from students was extremely favourable. They had enjoyed the experience, the audio and graphical reception was generally good (although there was one breakdown in communications during the tutorial), but more importantly they admitted to a positive learning experience. Somewhat unexpectedly, students reported a sense of belonging to a group, something they had not previously experienced.

With the current state of the technology, working over slow modems (14.4bps), the sound quality provided by RealAudio was much superior to that of Cu-SeeMe. However, the whiteboard and chat window (the mechanism by which students corresponded with the tutor and other students) worked well. The major problem with the set up was the delay in the tutor's output being received by students. Student responses were received by the tutor almost instantaneously, but the tutor's comments took up to 30 seconds to be received by the student. At times when the tutor was talking and drawing on the whiteboard all was well. However, when the tutor asked for student responses, not only did allowance have to be made for "thinking time", the electronic delay also had to be taken into account. In a situation in which there are no other signals emanating from students, it is difficult to know what the tutor should do: simply doing nothing does not seem to be an option. A communications line with no activity on it can appear not to be working and this causes the participants to worry over whether or not the technology is faulty instead of concentrating on the tutorial activity.

From the tutor's perspective, the following lessons were learned and will be useful in future tutorials:

- The tutor should not leave long pauses in audio output but should continue the dialogue in order to confirm that the tutorial is still "live" and there has not been a breakdown in communication. If a pause is required, the tutor should say so explicitly.
- The tutor should ask for frequent responses from students and not simply turn the tutorial into a lecture.
- As far as possible, ask questions which elicit brief answers (students and tutor alike cannot type quickly enough for anything else to be an effective use of the available time).
- The tutor should wait for a sufficiently long period of time for students to respond to questions. This is irrespective of whether or not there is any delay in the communications medium because there is no immediate visual or audio feedback from students to indicate that they have understood the question and, if so, whether or not they intend to offer a solution. The tutor just has to wait until at least one typed response is received. Rather than simply wait quietly, the tutor can repeat the question and give suggestions as to how the students might usefully go about providing an answer.
- Use techniques employed in TV presentations such as (a) slow movement of pointing devices and (b) synchronise the pointer with speech, that is, do not point at one thing and talk about something else.
- Remember that this may be the first time students have heard the subject matter being spoken. The actual pronunciation of technical terms (jargon) may throw the student.
- Keep the voice and content fairly "light-hearted" to maintain interest.
- Repeat the important parts of the commentary to overcome problems of poor audio transmission and breaks in concentration of the student.
- Recognise that the electronic system will fail (to some degree) and will inevitably detract from the tutorial.
- Remind students to take "notes" from time to time by taking a file copy of the contents of their whiteboard.
- Use both audio and visual mechanisms to convey instructions to the student.
- Be disciplined in the use of time, particularly in allowing student responses.
- Have well prepared files available for the major parts of the activity. Good preparation can avoid a lot of wasted "air-time".

Discussion

The tutorial was deliberately based on the investigation of a problem in computing that involved:

- analysing a piece of text;
- building up a diagram (of a binary search tree);
- using mathematical expressions.

Thus, the dynamic properties of the medium were exploited in the following ways:

- Students could observe how binary search trees were built up and hence deduce their properties.
- Students could provide expressions as part of a mathematical demonstration. Mathematics, if used wisely, can be a powerful technique in this medium because it can be the case that the solution to a non-trivial question can be stated quite succinctly.
- Various parts of a diagram or mathematical expression could be pointed to whilst being described.
- Cutting and pasting so that parts of a solution could be visually compared.
- Reading a question.

On the negative side, there is a great temptation for the tutor to take over the tutorial completely and fail to let the students interact. This seems to be due primarily to the remoteness of the participants. Without the visual and audio "clues" that one finds in a classroom (or that can be found in video communication) there is little feedback that can help the tutor decide how the tutorial is progressing from the students' point of view. Continual checking of the students well-being by asking questions seems to be one device that can be used.

Summary

The trial has shown that effective teaching can be provided synchronously via the Internet using relatively low cost and low-tech mechanisms. The Internet provides a solution to the problem of providing high quality tuition to remote students. The trial clearly showed that the important factor is the construction of a tutorial that exploits the facilities of the medium; the technical issues (of reliability and immediacy of response) need not be significant problems (and in time better technical solutions will be available). Thus, it is possible, with current low cost technology, to provide a high quality tutorial experience for students directly into their own homes.

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Appendix: The Tutorial Content

The tutorial dealt with a topic in Computer Science dealing with the specification of abstract data types. This lends itself well to audio-graphic tuition because it combines graphical notations, mathematical expressions as well as general descriptive matter. The tutorial was based on a typical examination question that the students were expected to have read prior to the tutorial.

The first part of the question asks the student to write down, in their own words, what the meaning of the syntax of an operation, named DATA, of the binary search tree abstract data type. The question gave the syntax as:

DATA: T → I UNION E

and defined the meanings of the sets T, I and E. The expected answer is a brief description of the input (a member of the set T) and the output (either a member from the set I or the set E), and nothing else. In the tutorial, it was possible to point to the elements of the syntax of DATA and describe each feature in turn. It was also possible to state verbally what information should not be provided in the solution to the question.

The second part of the question asked the student to complete certain axioms appearing in the semantics of an operation RIGHT. That is, they should complete the following mathematical statements:

RIGHT(CREATETREE) =
RIGHT(MAKETREE(l, i, r)) =

The two axioms were placed on the whiteboard (from a file) and the participants were asked to give their own solution to each axiom. As usual, some students were happy to try; others were less keen and were asked to simply support (or disagree with) the solutions being put forward. After a short pause while students were typing their responses (which should have been very brief), the expected solution was displayed by the tutor:

RIGHT(CREATETREE) = CREATETREE

and later,

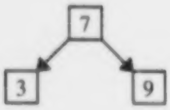
RIGHT(MAKETREE(l, i, r)) = r

Having written down the solution it was possible to analyse them, as a group exercise, deducing a particular pattern exhibited, and hence came to a conclusion about axioms that the students may not have observed previously. The pointing device and oral commentary were invaluable here.

Two more axioms were the subject of the third part of the question and again students were asked to complete them:

INSERT(CREATETREE) =
INSERT(MAKETREE(l, i, r)) =

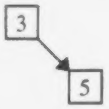
The axioms relate to the insertion of a value, e, into its rightful position within a binary search tree. This time, the solution relies upon recursion and it is particularly easy to reach the wrong answer even when taking a sensible path towards the solution. It so happened that the students chose the right approach and devised the correct solution. Even so, the question gave an opportunity to discuss why the solution is of a particular form and why an uncritical approach could lead to a wrong conclusion. To do this, the following tree was constructed on the white board:



and an incorrect attempt at inserting a value in the tree was illustrated. The illustration was simply by means of drawing diagrams to show the effect of the incorrect 'axiom':

INSERT(MAKETREE(l, i, r), e) = IF e < i THEN INSERT(l, e) ELSE INSERT(r, e)

which is an expression of the idea, 'if the item to be inserted, e, is smaller than the item in the root node, i, insert e in the left subtree, l, otherwise insert it in the right subtree'. In the example exhibited, e had the value 5, and a single application of the incorrect expression leads to the insertion of the item in the left subtree, the result of which is:



Clearly, this result shows e being inserted into the left subtree alone, and fails to 'remember' about the root node and right subtree of the original tree. The correct axiom is:

INSERT(MAKETREE(l, i, r), e) = IF e < i THEN MAKETREE(INSERT(l, e), i, r)
ELSE MAKETREE(l, i, INSERT(r, e))

Placing both the axiom and the example tree on the whiteboard enabled the students to see the actions of the axioms in relation to a concrete example. The ability to create the subtrees as the students watched was helpful in explaining what the axioms were trying to achieve.

The final point, often missed in distance education, is the fact that students main source of information is the written word and they seldom hear the subject being described which not only can be frustrating but also is a common source of misunderstanding (despite the care that we try to take to overcome this deficiency through the use of audio and video tapes). Therefore, a deliberate policy was to describe every part of a diagram or expression in detail.

Proxy Servers and Databases for Managing Web-based Education

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Abstract: The World Wide Web represents an information source that could revolutionize public education once difficulties associated with accessing and organizing the information are addressed. Tools to manage some aspects of Web-based information exist, but none that specifically address the needs of educators. We have created an experimental set of tools to facilitate the creation and viewing of topic-specific document collections drawn from the World Wide Web. The toolkit uses a proxy HTTP server and database system and we believe that this combination is a powerful way to solve some of the problems in using the Web for educational purposes.

1. The World Wide Web and Education

Educators need to make available to learners carefully selected information to provide structure and focus to the learning experience as well as to evaluate learning that results from the experience. The Web is a very unfocused arena with almost no structure [Ibrahim & Franklin, 1995]. In order to benefit from the Web's potential, educators must have tools to assist them with the structuring of Web-based material around some foci. Currently, educators' solutions to World Wide Web access for K-12 education fall into one of three categories:

1. *Access to the Web can be completely denied.*
2. *Access can be controlled via a list of 'unacceptable' or 'acceptable' sites. (the blacklist vs. the goldlist)*
3. *Access can be limited to a local Web or intranet that consists only of in-house documents and locally created material.*

If the motive is to provide World Wide Web access within educational settings, the first solution not an option. The difficulty with the second solution is that the lists of sites become out of date immediately. Also, although black and gold lists deal nicely with the problem of unacceptable material, they do nothing to create the pedagogical focus that an educator desires. Finally, despite the educational benefits of local webs and intranets, their creation and maintenance is grossly time consuming and requires significant expertise and computing resources. The resulting intranet may be extremely useful but educators may have to create many materials from scratch, or copy material from elsewhere. A collection of Web documents managed by a proxy server-database combination can provide most of the advantages of a stand-alone Web site, but it does not require educators to create materials from scratch and it can provide tools for data collection to assist with student evaluation.

2. Educational Management

Educators are managers. They manage students, resources and time to create the most valuable learning experience possible. Books, libraries, record keeping tools and timetables help with management of the traditional educational experience, but the World Wide Web provides little managerial help. The Web would be far more useful in an educational setting if it had better facilities for managing students, information and resources.

Student management is essential for meaningful student evaluation, both in terms of appropriate use of resources and skills, and in terms of knowledge gained/practiced while using the Web. Traditionally, student management is documented using paper records, an impossible task for a class of students working individually with Web pages. Some automated form of recording student interactions with the Web is required before educators can really analyze how individual students are using it.

Information management is one of the main tasks of educators. They are trained to select suitable information for a particular set of learners and organize the information to facilitate learner understanding and to maintain focus on a particular topic. Once information is selected for use, the context of the information is set by the fashion in which the material is presented to the students and by communication between students. Selecting information and subsequently sharing the selected information (in its original form) with the learners is difficult when the information source is the World Wide Web. Normally, educators use books known to be written by reputable authors and to contain accurate information. Authentication of web documents is a different matter. Although modern browsers and servers can ensure that the information ultimately received by the browser is the information originally requested, they can provide no assurances that the content of the page is original or accurate. Judgment about the accuracy of the information on a page is left to the user and there is no easy method to determine original authorship of information contained in a Web page. Web documents are unorganized and the educator usually has little control over the context in which learners view pages.

Educators and students have always shared comments and observations about learning materials as part of the learning process. The educator provides guidance to learners as they explore the learning materials. However, sharing comments about Web documents can be difficult, since learners are often working asynchronously and sometimes in isolation. Currently the World Wide Web provides little assistance for shared communication, although some researchers are investigating the use of document annotations as a teaching tool [Roescheisen et al., 1995].

Often, even when a suitable Web page is found for a topic, it may be unreachable (because of network traffic and computer server failure) during the times students have access to the Internet. Even if the document can be reached, increasing network traffic will likely mean that much of the student's time is spent waiting for it to download. The waiting time increases when learners who are unfamiliar with hypermedia systems request irrelevant or unusable documents and then must make additional requests to find usable material. Many educators choose not to use the World Wide Web in an attempt at more effective resource management.

3. Management Tools

Management of Web resources is not a new problem and has been the subject of much research [Maurer & Schneider, 1995]. The solutions that have been proposed for the server side of the Web can be categorized into CGI solutions, special-purpose Web servers, and proxies. Client side solutions, such as Java applets are not considered in this paper.

CGI (Common Gateway Interface) provides a protocol for Web servers to communicate with external programs such as database servers. From an educator's point of view, however, CGI scripts do not provide all the required tools. First, scripts usually must be written by a computer programmer. Additionally, CGI scripts do not always give the educator enough assistance in managing students or resources. Finally, it is difficult to monitor learners using CGI scripts alone.

Specialized HTTP servers, such as HyperG [Andrews et al., 1995], add navigational support to Web pages, monitor user interactions, and maintain a database of meta-information about the documents belonging to the server. Specific-purpose HTTP servers may define a special protocol for communication that could complicate interactions with the rest of the Web. Additionally, the server must be contacted directly from the client to provide its extended services to the learner. Should learners make a request to an alternate Web server they will no longer have access to the specialized navigational tools supplied by the enhanced server. Specialized servers are fine for institutions wishing to create local intranets with limited access to the larger Web, but they are too restrictive and costly for widespread Web access and common educational settings.

Proxy HTTP servers provide both a means to monitor student progress and add navigational links to Web pages. Learners are not restricted to the use of a single Web server while using a proxy. A proxy server combined with a database can provide excellent support for educational uses of the Web. Both databases and proxy servers have been used to address different aspects of managing the World Wide Web. The remainder of this section will discuss some of the current uses of the two.

3.1 Databases

Database systems are already used to store student records. Once the data are entered, automated processing furnishes educators with detailed information about each student. The educator can then construct an accurate representation of what the student has accomplished and discern which material the student has yet to learn. This model of individual students is extremely useful to human educators, but is also useful to computer-based intelligent tutoring systems and adaptive hypermedia systems. A well represented student model can allow an adaptive hypermedia system to tailor the display of a collection of Web pages for individual students [Brusilovsky, 1996].

A conventional database used in parallel with a Web server can provide information about Web documents which have proved useful, or can be used to populate Web pages on-the-fly [Rasmussen, 1995]. Within education, database systems can be used for structuring information about electronic documents to improve their organization. The database system functions much like an electronic card catalog for the Web. Once information about courses (or students) is recorded in a database, a Web-database gateway is used to connect the database to a World Wide Web server. Web-database gateways are CGI scripts enabling communication between Web server and database system. For example, a database gateway could create Web pages containing student progress reports using information exclusively from a database of student information.

In spite of the usefulness of database gateways, there are two areas for which databases provide no assistance. Web-database systems do not ensure that learners work with specific Web pages, and they provide little assistance with data collection because the gateway has no knowledge about which data to collect. A proxy HTTP server can be used both for data collection and access control.

3.2 Proxies

A proxy HTTP server is a computer program that operates as an intermediary between the World Wide Web client and the HTTP server [Altis, & Luotonen,1994]. During a regular transaction between client and server, the client contacts the server directly, requesting a particular Web page. The server retrieves the page (or an error message if the page is unavailable) and sends it back to the client. A proxied communication is similar except that the proxy is in the middle. Thus, the communication sequence is client-proxy-server-proxy-client [Figure 1].

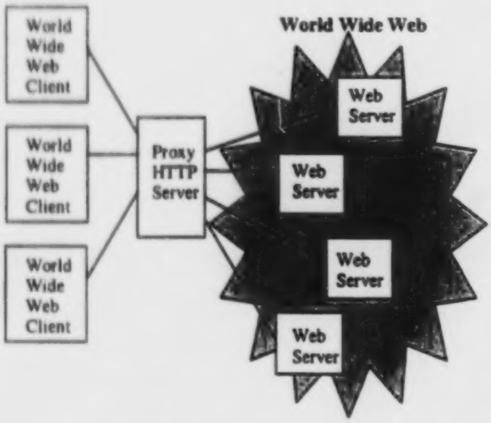

Figure 1: Proxy HTTP Server

Traditionally, proxy servers have been used to improve network performance and to provide secure access for persons using the Internet from behind a firewall. Network performance can be improved because the proxy server can act as a cache for pages that are requested frequently or it can act as a load balancer which redirects requests to less heavily-used sites [Brooks et al., 1995].

Within an educational environment, proxy HTTP servers can serve two functions. They can assist educators in managing information and learners and they can reduce the resources required to provide World Wide Web experiences to a number of learners. The use of a proxy server frees the educator to use any available Web client (browser) and to use Web pages from any server without losing the management features of the proxy. For example, an educator who prepares a structured set of Web pages to illustrate a particular concept usually places those pages on a Web server. Students are given the URL of the collection but may choose to wander off to completely different Web pages on different servers because the educator has no means of ensuring that students use the prepared material. Alternatively, if the learner's Web browser is connected to a proxy HTTP server, each request the learner makes must pass through the proxy. The proxy can be set to refuse the learner's requests for Web pages that are not part of the educator's prepared document collection.

One implementation of a proxy HTTP server locks the learner's Web client to the educator's client, thereby allowing the educator to present a series of Web pages as a 'slide show' which students watch along with the instructor [Yeh et al., 1996]. Similarly, a proxy server can be used to add value to existing World Wide Web pages. A request for the page is made to the proxy which then retrieves the desired page. Before the page is displayed to the user, additional information, often in the form of navigational aides or annotations can be added [Hauck, 1996].

A proxy HTTP server placed on a school's network system not only provides potential information management for educators but it can also act as a cache for frequently accessed documents, reducing the amount of traffic generated from the school and possibly reducing the cost to the school for network access. Proxy HTTP servers can help with information and resource management when educators use the Web as an instructional tool but they do not provide the organizational and record keeping assistance available from a database system. To get support both in managing and organizing World Wide Web information, a combination of a proxy HTTP server and a database system proves most useful.

4. The MicroWeb Toolkit- A Proxy Database Combination

Proxy server-database combinations allow educators to use a database for keeping data about both Web pages and about students. The proxy HTTP server facilitates the collection of the data and can act as a 'librarian' by guiding learners to appropriate materials. It can also augment the original Web page with annotations or other information from the database. The database can store and organize meta-information about the Web documents and the organization of the document collection. A proxy server can collect the desired information about learner skills and knowledge and place it in a database for use by the educator or an intelligent tutoring system. Web resource consumption can be minimized through the use of the proxy's cache and by reducing the number of irrelevant pages the learners request.

Proxy servers have already been combined successfully with a database (in the guise of a separate server) to provided support for document annotation on the Web [Schickler et al., 1996]. Annotations allow learners to share experiences and observations about document collections asynchronously. GrAnT (Group Annotation Transducer) was constructed using the concept of an application-specific stream transducer [Brooks et al., 1995] and a previous prototype for a tool to provide in-place annotations of World Wide Web documents [Roescheisen et al., 1995]. The result is a proxy server that accepts requests for Web documents, authenticates the user before retrieving the document, and adds existing annotations to the document before presentation to the user. GrAnT also allows authenticated users to add annotations to documents. The 'database' for this system was not a relational database system, but an annotation server which provides limited database functionality for this system.

A second system that is similar to a proxy-database system is Interbook [Brusilovsky, 1996]. Interbook is an adaptive hypermedia system that is designed to present individualized electronic textbooks to learners. Interbook collects data about users' interactions with the textbook to make decisions about which part of the book learners should see next. Interbook uses a special-purpose HTTP server, rather than a proxy server. The use of a stand-alone HTTP server adds the requirement that all actions must be directed to the specialized server in order to use the enhanced set of features.

We have created a prototype proxy-database system intended for use in the K-12 school system. Our prototype allows educators to define document collections using any Web documents (from any valid server) and provides facilities for learners to view and annotate those documents. Our software set is called The MicroWeb Toolkit [Thomson, et al., 1996].

The MicroWeb toolkit simplifies the compilation of organized topic-specific hypermedia collections from the World Wide Web. Educators may use existing World Wide Web documents as instructional material while avoiding many of the previously discussed management problems associated with the Web.

A MicroWeb collection is created by an expert Web user using a planning tool, called the MicroWeb Control Environment, to organize the concepts for the topic, to organize documents within the concept web, and to record information about collection documents in a relational database. A completed MicroWeb collection is viewed using an application-specific proxy HTTP server, called the Collection Viewing Proxy, which merges the information in the database with the requested World Wide Web document and sends the result to the user's browser [Figure 2].

Learners may be restricted by the Collection Viewing proxy to viewing only those documents that are part of a MicroWeb collection, or they may be allowed to explore external parts of the World Wide Web. Learners may view documents, follow hyperlinks within the text or from navigational links supplied by the proxy, or may comment on documents by adding annotations. Learner annotations are available for other learners to view, facilitating peer cooperation. By supporting the learner in a hypermedia environment it is hoped that skill in using hypermedia documents will be gained at the same time as useful information is found.

The MicroWeb toolkit, and the combination of proxy-database in general, has great potential within an educational setting. Through the proxy server all learner interactions with a collection are recorded in the database. The educator may use this database information to analyze learner performance and make decisions about future work the learner must do. Learners who work within a document collection remain focused on the subject matter and have less opportunity to get lost in hyperspace because the collection is topic specific. The educator is confident that the material students are working with is accurate and appropriate because it has been selected specifically for the collection. Finally, computing and network resources can be conserved because an entire collection can be cached by the proxy HTTP server eliminating further network traffic unless non-collection pages are requested.

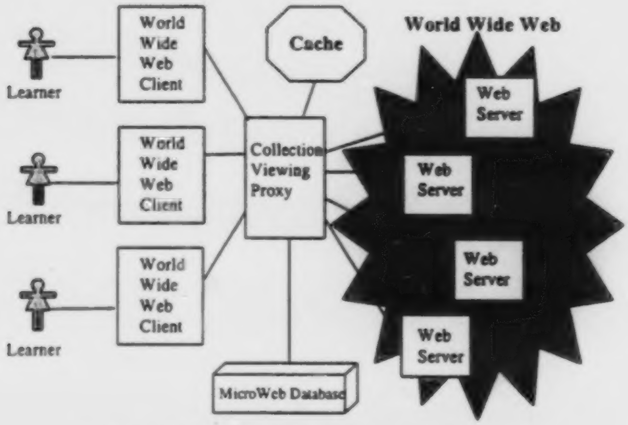

Figure 2: MicroWeb Collection Viewing Proxy

5. Conclusions

The management problems we referred to previously can be addressed by using proxy HTTP servers combined with a database. The proxy server facilitates management of students and information, allowing the educator to monitor progress without physically watching each student, and the database allows organization of the collected information for efficient retrieval. One such proxy database system, the MicroWeb toolkit, has been developed by the authors to expedite the creation of topic-specific document collections using World Wide Web documents and to allow viewing of the created collections on standard Web browsers.

The MicroWeb toolkit addresses many of the problems encountered while using the World Wide Web as an educational resource. It has been used to create sample document collections, and will be evaluated with learners and educators during the summer of 1997. Proxy-database combinations seem to have exciting possibilities for educational Web applications. Because of the ease with which the combination can collect and analyze data, its use could be extended to many other aspects of education.

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Compressed Video Technology in International Architectural Reviews: an Instructional Application

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Abstract: Addressing the potential for trans-national design consortia and international professional consulting offered by the North American Free Trade Agreement (NAFTA), the paper makes reference to the instructional objectives of international architectural reviews and the actual implementation of a "virtual design studio" that brings together Texan and Mexican design students by making use of compressed video technology. As conclusions the paper offers a list of findings that confirm original assumptions, create new working hypothesis, and motivate future research.

Design Studios in Architectural Education

In the curricula of architectural education it is common to find a structural back-bone made out of a sequence of "design studios". Design studios are complex instructional environments oriented towards offering a vast range of hands-on learning opportunities (Angulo 1995). In a design studio, students learn to design by designing architectural objects of increasing levels of complexity until acquiring the knowledge and skills needed for handling complete buildings in a working/learning environment somehow analogue to our professional design offices.

For an observer, a professional design office is an enterprise nourished by the experience of one or several senior architects and their interaction with a body of less experienced design collaborators. In such a framework we may find a wide variety of scenarios that need to be emulated in our instructional design studios. For instance, in a professional design office it is frequent for the senior architect to call upon a collaborator and brief him/her on the requirements and constraints of a new project. Depending on the size of the design firm, it is possible that following such an event that same collaborator may add some requirements to the design problem and brief other design collaborators that will then initiate a study on the subject and start to render design ideas. As design ideas start to emerge, more experienced designers will sit together with less experienced designers for conducting "design crits". Design crits serve as brainstorming sessions for the further development of the project. As the project starts to take shape, design crits will call for the participation of senior designers.

In analogy to the scenario of design briefings and design crits in our professional offices, we have managed to develop similar dynamics in our instructional design studios. For such matter, our schools count with large rooms properly furnished with drawing tables, meeting areas, and pin-up walls that emulate the environment of professional studios. In such environments, a design instructor will meet with a group of 12 to 16 design students for conducting design briefings, design crits, and all the additional activities relevant to the process of designing a building. Instructors will be likely to meet with their students on the basis of 3 times per week, but beyond such schedule students will be expected to develop a complete life style around the development of their design projects and virtually move into their studios.

In some schools the analogy that shapes our design studios has been expanded by introducing the participation of teaching assistants under the direction of senior instructors. In such cases an internal hierarchy of expertise, similar to the one we may find in professional offices is generated. In some other cases, we may find that students of different levels of skilfulness are put together to work on a single design project, and in such way generate conditions for the establishment of team work and leadership.

As a common denominator, in every design studio we can identify the following dynamics:

- Formal lectures in which the instructor stands in front of the students and lectures them on subjects related to design theory making use of a blackboard or white board, an overhead projector, a slide projector, or a data/video projector.
- Seminar meetings in which the instructor and the students sit together on a circle for discussing theoretical and/or ethical issues.
- Design briefings in which the instructor offers a presentation on the design project at hands. The instructor will address design requirements, design constraints, an architectural program, a design schedule, etc. Students are likely to interrupt at any time with questions and/or suggestions as if addressing a client embodied in their instructor.
- Individual crits (also called desk crits) in which the instructor moves from student to student as they work on their projects. Individual students will briefly show what they are currently doing and the instructor will offer individual advise on how to correct design defects or improve design content.
- Peer crits in which students will meet in small groups of 2 or 3 people for reviewing their designs and offer advise to each other.
- Pin-up reviews (also known as informal reviews) in which students will pin-up their projects for any one to see and comment on an individual basis
- Collective reviews (also known as formal reviews) in which students will present their projects to a group of instructors and their peer. Anyone can intervene with questions, remarks, or comments that may hi-light positive of negative aspects of the design.

During a regular semester, a design studio will visit the above mentioned dynamics at least once. In some cases design studios may schedule several design projects per semester or address a large project that calls for the implementation of several formal and informal reviews.

A New Generation of Design Studios

As our profession moves into the use of computer technology, our instructional environment needs to react accordingly, and if possible, anticipate the trajectory of its application in our design offices.

Addressing our need to keep pace with design offices, most schools of architecture have implemented computer laboratories in which students find computer applications for assisting them in the generation of design documents. Drafting programmes have been available for a long time and by now most schools also offer solid modeling resources. Beyond the productive role assigned to computers, there is a slow but consistent move of the profession and colleges of architecture towards the use of computers as actual design tools. "Electronic Design Studios" (Mitchell & MacCullough 1991) are becoming more and more common as we accumulate valuable experience on how to introduce computers in some of the dynamics that define the way in which design studios work.

But beyond the use of computers as isolated tools, or as components in local networks within a single design firm or college, we are starting to see that national and international networks can be used for conducting design related activities. Design firms are starting to make effective use of the Internet for establishing design partnerships. Partnerships that are not restricted to a national context but can actually open doors to the export of our design expertise. This potential is quite evident in Texas and Mexico where due to our cultural heritage we are specially well qualified for addressing our mutual needs and aspirations.

Having in mind the kind of knowledge and skills that our graduates would need to have for dealing with an international design context, and the kind of tools they will need to embrace for such a purpose, we have developed an instructional design studio that seeks to address such knowledge, skills, and instrumental resources.

The Tex-Mex Virtual Design Studio

In the process of developing an instructional environment able to address effectively the knowledge and skills required by an architect that seeks to operate in an international computer-mediated context (Vásquez 1996), we

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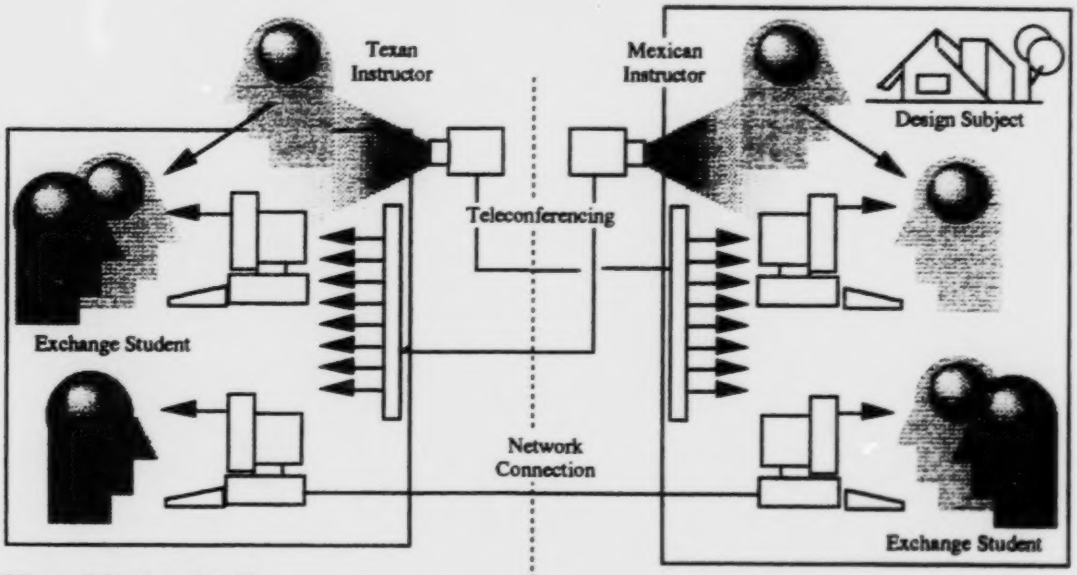
started by establishing an international partnership that could emulate such operational conditions. Through mutual agreement in early June 1996 the College of Architecture at Texas A&M University in Texas and the School of Architecture at La Salle University in Mexico City initiated the process of defining the instructional targets to be jointly addressed and the resources needed for supporting the intended dynamic.

From the offset, we all agreed on the need to maintain every single dynamic of our conventional design studios in place. Our intention was to add on our current instructional targets and not to replace them on any way. The instructional targets we decided to add can be outlined as follows:

- Acquisition of knowledge related to the cultural context of our counterparts. The use of a second language was of prime importance in this framework.
- Acquisition of knowledge related to the professional context of our counterparts. Factual information on the environment, building resources, and building constraints were to be given particular attention.
- Acquisition of skills on the use of Internet resources and applications. Initially the use of e-mail, FTP sessions, and WWW documents was foreseen.
- Acquisition of skills on the experimental use of compressed video technology. In particular the unprecedented implementation of international architectural reviews was anticipated.



Virtual Design Studio Dynamic

By the end of the August 1996, two groups of design students of 4th year, one in Texas and the other in Mexico City, were selected for the experience. Initially our intention was to limit each group to 12 students but due to administrative requirements the group operating out of Texas had to be upgraded to 16 students.

In anticipation to the workload to be imposed on students and instructors, it was decided to split some of the added instructional targets. For this purpose it was decided that the official language of the studio was to be English and that the design subject was to be established in Mexico. Under such arrangement, Mexican students were offered the opportunity of practising their English at the same time that Texan students were offered the opportunity of learning more about the cultural and professional context of their counterparts.

The design subject chosen for the exercise was a five stars holiday resort and cyber-colony in the Mexican island of Cozumel. Beyond the implicit attractiveness of the subject and the fact of being immersed in a Mexican context, the subject was in particular interesting because it addressed the question of how architectural objects should make reference to the growing trend of telecommuting from remote locations. Through the chosen design

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exercise we saw the potential for experimenting with networks at the same time that we addressed an architecture that may help support such dynamics.

The design studio in Mexico City was established on the basis of a traditional design studio instrumented through the use of drafting tables and a model-making workshop. The design studio in Texas was implemented on the basis of an electronic design studio instrumented through the use of computer aided drafting programs and solid modeling programs. Both groups had access to Internet connections and a direct compressed video hook-up.

The first dynamic to be implemented was a design briefing. For such a purpose a compressed video teleconference of 3 hours was scheduled. Following the initial introduction of each student and the instructors, the Mexican studio presented an overview of the location selected for the project and a considerable amount of information referred to the Mexican context. Texan students reacted with a number of questions and interactivity between the two groups became almost as intense as in conventional design briefings.

Following the design briefing and in order to make it possible the implementation of desk crits, peer crits, and pin-up reviews, the students were asked to put up web pages showing their projects as they evolved in time. Student web pages were accessible through course web pages and a large number of remote hyper-links. Many students set their web pages in such a way that they could offer not only a view into their projects but also a view into their lives.

As the content of web pages started to grow, students started to exchange comments making use of e-mail. In this way a dynamic analogue to desk crits and peer crits was implemented and in certain cases a climate very similar to the one typical of pin-up reviews was notorious. As a general rule, the students receiving comments from a peer acting as a reviewer were urged to fulfil the courtesy of reviewing the project of such peer and render a crit of their own. Through this process students became more familiar with each other and came to grasp an initial understanding of some of the many projects that were on development.

For the implementation of collective reviews, 3 compressed video teleconferences were scheduled. Each teleconference had a different objective. The first one was to be somehow informal and cover aspects of conceptual design. The second one was to be somehow formal and cover aspects of building design. The third one was a formal review of complete projects including details and interior designs. Each review was scheduled for a duration of 3.5 hours.

For our first collective review it was decided to use the same teleconferencing facilities that were used during the previous meeting. Our objective was to permit every single student to present their projects and answer questions from their peers at the other side of the line. Thanks to well-controlled timing it was possible to cover all the members of the studio but through such process a number of interesting facts started to show.

In particular, it is worth mentioning that the Mexican site had only one moving camera able to cover the teleconferencing room and a small document camera mounted on a table. Students had been working on conventional drawings of large format and physical models of relatively large dimensions. The problem they had to face was to determine how to put such documentation under the view of their cameras. The resolution of a tele view on large drawings was low and the use of the document camera for viewing the physical models was very time consuming. In this regard there was a clear need to spin the models and be able to see them from different angles, as we would do at the time of moving around a static model.

The Texan site had two room cameras. One was used for a fixed view of the students and the second one was used for focusing on specific students as they presented their projects or made questions. The Texan site also counted with a camera for small size documents. In anticipation to the limitations imposed by the equipment, the Texan students developed most of their work on the basis of small format drawings transferred to overhead transparencies. The main problem with this approach was that the transparencies as exposed under the document camera reflected some of the lights on the ceiling. Furthermore, freehand drawings that look fine at the time of using an overhead projector adopted a childish character when transferred to the video monitor. A number of students had to improvise transferring some of their drawings back to paper in order to offer a better view of their ideas.

On the overall, interactivity between students was far more fluent that during the preceding design briefing session, but the price to be paid came on the form of limited participation from the instructors. During a conventional collective design review, instructors tend to take as much as 70% of the time available for comments and questions, but in the context of our teleconference the instructors were so busy maintaining control of cameras, focus, and audio that their participation became somehow superficial.

For our second collective review the technical set-up in each site was somehow different. In general terms it would be fair to say that both groups managed to get their message across the interface but it was obvious that both set-ups required massive improvement. In particular we can outline such areas of improvement as follows:

- Conventional moving cameras do not render the quality required for the display of large format pin-up drawings. Better results may be obtained by using a hi-resolution camera similar to the one used for small format documents.
- The display of physical models is constantly disturbed by the movement of the model and the consequent effort of the camera to re-establish proper focus. Better results may be achieved by devising a turn-table system on which the physical model could be turned around in a slower and smoother fashion.
- The use of cameras that may feedback on images of the remote location is of fundamental importance during the rendering of a crit. We need to explore ways to improve the quality of the remote image on the feedback and add the possibility of real-time graphic interaction through the use of a whiteboard as video projection screen.
- Audio control is a constant problem due to the background noise of equipment, as for instance data projectors, the movement of people in and out of the audio pick-up areas, and management of different tones of voice among participants. The use of ceiling-mounted microphones or table-top microphones has been unsatisfactory. We may improve the quality of audio pick-up by adding some wireless clip microphones to the general set-up.
- Instructors tend to be anchored to the control panel. The use of a remote control, a wireless clip microphone, and perhaps a movement tracking camera may come to free the instructors from a specific location in the teleconferencing room.

Our intermediate video-review had a strong impact on the design performance of both groups. A healthy competitive attitude was reinforced but shortly after students started to divert considerable attention from the design process into a documentation process. Students felt the pressure of having to show their projects in a more effective way. In a number of instances, design instructors had to discourage students from pursuing fancy documentation at a cost in design quality.

The commitment of the students to maintain up-dated web pages was higher in the second half of the semester. In part this may be attributed to better skills on the handling of network resources and larger availability of design documentation for maintaining a pin-up review. In general terms the tendency of most students was to show their projects rather than to offer a crit to their peer.

The last video-review of the project was mainly a presentation review in which all the participants of the Tex-Mex Virtual Design Studio had a chance to show their projects. The amount of crit that was exchanged was very limited due to time constraints. Following the last video-review of the project, both groups conducted final pin-up reviews in their own schools and documented their projects for final display in the WWW.

For further information, the web page of "The Tex-Mex Virtual Design Studio" is situated at: http://archone.tamu.edu/~ARCH405/

Conclusions

The research and development adventure hereby described has permitted the formulation of the following conclusions:

- In order to maintain the paradigm of an instructional environment that reflects current professional practice, and if possible anticipates technological applications, we need to transfer a number of key instructional dynamics into a computer-mediated context.
- In the domain of architectural education we need to address a growing tendency of the profession towards the use of networks as base for the consolidation of international design partnerships. In particular the potential for Tex-Mex design partnerships and bilateral consulting adventures needs to be addressed.
- Based on previous experiences in the development of "Virtual Design Studios" (Bradford, Cheng, & Kvan 1994), the use of Internet for establishing a fundamental link between design teams has proved to be feasible. This feasibility has been however limited to some of the many dynamics present in the framework of a design studio, namely: desk crits and pin-up-style reviews.

- Based on present experimentation in the context of our "Tex-Mex Virtual Design Studio" we are accumulating substantial evidence that points towards the feasibility of implementing a wide variety of communication dynamics.
- Based on further experimentation in this field it may be possible to prescribe the configuration of instructional environments specially developed for the purpose of offering instrumental base to a new generation of design studios.
- Future implementations of The Tex-Mex Virtual Design Studio during 1997 will target the question of instrumental transparency and output media.

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A Model to Assess the Value of WWW-Based Applications in Stimulating Productive Engagement by Students

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Abstract: The analysis of factors that affect student's success rate in higher education has a new impulse in The Netherlands, stimulating in particular a focus on what students themselves perceive as critical. The productive engagement of students is defined as working in an efficient manner, with good study habits and intellectual commitment. How can telematics help support this on an university-wide basis? In particular, how can the use of the WWW be oriented around a goal of increased productive engagement? We give an overview of how the IDYLLE Project at the University of Twente is stimulating investigation of these questions.

Improving the Efficiency and Effectiveness of Higher Education at the University of Twente: The IDYLLE Project

The University of Twente is a university with a strong technical orientation and a leader in The Netherlands in the field of telematics, in terms of research, in facilities available to all students and staff, and in terms of use of telematics applications as integral aspects of how we all work. This leadership includes innovative applications of telematics in our mainstream courses, as well as in various experimental course settings and in supporting the research of our graduate students and staff when on projects outside the country [Collis, Andernach and Van Diepen 1997; Pouw, Van der Veen and Andernach 1997]. As part of the University's commitment to its telematics profile, an interfaculty Centre for Telematics and Information Technology (CTIT) has been established, combining both technical and social-application emphases. The Faculty of Educational Science and Technology and the Faculty of Computer Science are major partners in the CTIT. In recognition of the potential of both the CTIT and telematics more generally to make substantial and serious contributions to the social and economic growth of The Netherlands, the Board of Governors of the University has awarded the CTIT a major four-year grant to turn its efforts to the benefit of the university itself: How can advanced telematics applications improve education at the University of Twente in a measurable and meaningful way?

The IDYLLE Project is responsible for this applied research, and has recently completed its start-up year [see Van de Kamp & Pouw 1997]. Among five specific projects and a variety of other initiatives, the Project is involved with developing more effective groupware tools for project management for staff and students alike in the many courses at the University that involve students working in (often geographically distributed) groups on complex design problems [Van der Veen & Collis 1997] and with developing and integrating networked multimedia databases as educational resources so that, for example, video on demand services can extend the lecture in time and location and can link portions of instructor demonstrations to other forms of electronic study materials. Further information about the Project is available from [IDYLLE 1997].

But the IDYLLE Project is more than a collection of advanced-telematics initiatives; it is an integrated research project grounded by an conceptual and empirical analysis of key factors that affect educational quality and productivity in higher education. This analysis has resulted in a hypothesized model of factors that affect the efficiency and effectiveness of the educational process, and in particular that affect the rate in which students complete their studies. One goal is that an increase in the rate of student throughput occurs, without decrease in the high standards expected of students at the University or in the opportunities that students take advantage of to study abroad or to do their final projects in settings outside the University. As a result of a variety of analyses, we have hypothesised students' "productive engagement" as an important component of their rate of successful and efficient completion of their studies [Van de Kamp, Collis & Moonen, 1997].

Productive Engagement: A Critical Student Variable

We define productive engagement as occurring when students, given appropriate instructional tasks and goals and effective supervision and instruction, become mentally involved in their studies, work effectively and efficiently at their tasks with good self-regulation and with on-going self-evaluation. The productively engaged student is not wasting time, not spending too much or too little, but is investing time in a well-organised way so that he not only sees the relationships in the various aspects of a course, but becomes self-motivated to become increasingly professional in his own intellectual behavior. While productive engagement is difficult to succinctly define and objectively measure, the IDYLLE Project is nonetheless taking it as a critical focus, and as a starting point is using the operationalization of "how time is spent in a course" as an analysis variable. If students work efficiently and if the course is appropriately offered, they should be able to complete a course in a satisfactory manner in the time allotted for the course. Does the time they spend pay off for them? If not, why not? Can telematics help?

After various pilots, a survey has been carried out among a sample of 226 students representative of different faculties and years of study, asking the students to indicate from a long list of various factors how much each factor tends to affect their productive engagement of time in a course. The results of the analysis are given in more detail elsewhere [Van de Kamp, Collis & Moonen, 1997] but show three clusters of factors to emerge as most influential from the students' own perspectives: (a) a cluster related to the student's personal level of motivation and interest in a course; (b) a cluster related to the degree to which a course is well-organized and well-integrated; and rated as most important, (c) a cluster related to the student's own study skills.

Interestingly, variables often assumed as important to student performance, such as opportunities for more frequent or more informal discussions with the instructor, and opportunities to study with other students or to be engaged socially with other students in course activities, were not selected by our responding students as having particular effect on their productive time investment in a course. Also, while concerns about personal finances were not seen as having much effect on their efforts, personal time constraints were seen as a serious constraint. While cultural variables may distinguish these students, enrolled in a Dutch university emphasizing the technical sciences and with high demands on its students, from other cohorts, the pragmatic nature of students in higher education has been noticed by us in other countries and different sorts of university contexts.

Relating the Use of the WWW to Productive Engagement

How does the WWW, as one of the current applications of telematics most widely in use at the University of Twente, relate to these three clusters of factors that appear to be important to students' productive engagement? How can the use of the WWW be steered so that these factors are emphasized? We are now identifying examples of WWW applications that appear to be closely associated with these clusters, and doing some first data collection relating to the hypothesis that students' productive engagement in a course, operationalized as spending time productively, can be heightened through applications of the WWW that focus on motivation, efficiency of course organization, and support for better study skills. Following are brief discussions of WWW-based applications relative to each of the three clusters, using two particular courses at the University of Twente as examples. These courses are both for first-year students, one in the Faculty of Educational Science and Technology (called "Introduction to Instrumentation Technology" or "ISM-1"), and the other in the Faculty of Informatics (called "Applications of Information Technology" or "AIT"). Both courses have been re-engineered to WWW-based formats [Collis 1996] [Collis, Andernach & Van Diepen 1997] and can be visited at:

ISM 1: http://www.to.utwente.nl/ism/ism1-home.htm

AIT: http://wwwedu.cs.utwente.nl/~aitnlpbg/welcome.html

Cluster Related to Motivation:

The survey responses indicated the importance of the student's extrinsic and intrinsic motivation and interest in a course to his or her engagement in the course. This was expressed not only in terms of the student's own individual interest in and motivation for the subject of the course and its the particular objectives of the course, but also more indirectly through the value that students attached to perceiving the meaningfulness of a course relative to what actually happens in practice.

The WWW can be a powerful tool for stimulating these sorts of motivation. One way this can be done is already becoming commonplace: through the external hyperlinks that can be supported in a WWW site, the instructor can easily link the students to large repositories of information and current developments relative to the subject matter of the course but also can make these links in a more fine-grained way, directly connected to a particular aspect of the study material or materials describing the assignments of the course.

But showing how the subject matter of a course relates to issues and practice in the real-world can be made even more motivational for students if the students themselves can contribute such examples to the course materials. The WWW provides convenient facilities for such student-contribution to the study material in a course, heightening not only the students' awareness of the application of the course in practice, but also his or her sense of personal investment and engagement in the course materials themselves. Until the WWW there was not such a common and convenient way to integrate student-found examples into course study materials, and for the instructor to link these to existing study materials and to student assignments. An example of this can be seen in the course "ISM 1", in which students fill in CGI forms that indicate the URLs of WWW sites that they have found that are relevant examples of the content being elaborated in the course. These submissions are directly integrated into the course WWW site, and used by the instructor as subsequent study, and even as the focus on questions on the course examination [see also Collis & Meeuwsen 1997]

Motivation can be stimulated in many other ways via a judicious application of the potentialities available in a WWW site. For example, study materials in not only in the modalities of text and static images but also in sound and moving video can be made available to students, increasing the chance of appealing to the various modality preferences of the students. Examples can be seen at the ISM-1 site, not only in terms of links to external sites containing movies and audio, but also in terms of being able to link in movies and audio files made by the students themselves and subsequently used as reference and example material for the course.

Finally, personal interest in a course can be stimulated by using the WWW environment as a tool for new forms of communication and collaborative work. When students can, and must, work collaboratively with others in a different location via a WWW site on some sort of activity meaningful to the goals of the course, the opportunity is heightened for students to feel a sense of personal engagement in the course, and thus, perhaps, a heightened sense of intrinsic motivation and interest in the course. An example of this can be seen in the AIT course, in which students carry out the course assignment by working collaboratively with students in Finland, entirely through the use of different telematics tools [Pouw, Van Veen & Andernach 1997]

Pragmatic Aspects of Course Organization:

From the survey results, two associated subclusters of variables emerged that together we have interpreted as relating to the efficiency of course organization. The subclusters represent two levels of pragmatism on the part of the students. One level relates to efficiency at the adminstrative-organisational level (Can students find the information they need in a time-efficient, location-independent way? Will this information always be up-to-date and the same for all students? Will students have a convenient and timely way to ask a question and get an answer?). All of these relate to the impact of time constraints on the students and their high ranking they gave to "clarity in the course organisation" on the survey.

The other subcluster relates to what might be called the content-related pragmatics of the course. Students want to know why they should be doing a certain activity or studying a certain reading; in a practical way, they want to know what relevance this has to them in terms of successful completion of the course, in terms of their marks. That the students indicated on the survey they highly valued an instructor who could present material clearly may also relate to this desire for "content-related efficiency" or "content pragmatics" on the part of students.

The WWW can be used to emphasise both these aspects of efficiency. In terms of adminstrative-organisational efficiency, the use of a WWW site to provide a central place, where independent of time or access point of one's browser, the student can access any course-related information is clearly a use of the WWW that is gaining in familiarity. The two example courses to which we are referring, ISM-1 and AIT, have both fully integrated all their adminstrative aspects within their WWW sites.

Content-related efficiency, pragmatics, can also be supported through the use of WWW functionalities. The instructor can add links to direct the students' attention to the intended points of interrelationship in a course, particularly interrelationship between theory and examination and assignment-grading criteria, and between practical activities and examination questions. The instructor can also add parenthetical comments to entries in a site, via links, in which the intended relevance of an entry is further described for the students. A description of evaluation procedures and criteria in a course can be linked to the conceptual materials underlying them so that students are reminded of *why* they should learn something or do something to a certain standard in order to successfully complete course assignments or examinations. Exemplars of student work demonstrating good and excellent levels of achievement can be linked to, and used to reinforce instructional points as well as clarify expectations with respect to assignments.

But even while the students indicated their appreciation of efficiency in a course, they gave highest rating overall in the survey to their own study-skills and habits in terms of factors that influence their productive engagement in a course. We discuss some examples of how the WWW can support the development of self-regulated learning and study skills in the next section.

Improvement of Individual Study Skills:

The students responding to our survey indicated their own study skills, their ability to summarize, to structure, to reflect, and to plan and their overall self-discipline as the variables most important to their productive engagement in a course. The WWW can also support the development of these skills in self-regulation in a variety of ways. One is to make available "cognitive tools" of various sorts for the student to use, so that he or she can be reminded, and facilitated, in study habits such as note taking and self-testing. But student self-regulation can also be coached, or "scaffolded", in a variety of ways within a WWW site, depending on how much prompting is given in terms of planning or reflection or other self-regulatory skills. How to do this effectively with WWW sites serving students who are working with the course at different times and in different conditions relative to their learning histories and needs is the focus of a new research project at the Faculty of Educational Science and Technology.

Student Experiences with the WWW: Is Productive Engagement Being Heighted?

The above examples show, in concept, how certain applications of the WWW can be argued as good candidates for the improvement of students' productive engagement of a course. But how can this be tested in practice? So far, we have a considerable amount of anecdotal evidence about student use of WWW environments, and factors that constrain that use, but we are only beginning to empirically investigate the relationship to productive engagement and time investment. From our anecdotal data to date we can note a sample of the reactions of students to our own use of WWW-based course environments that suggest both support for our hypothesis but also the need for its refinement. We list several of these indicators below:

- With respect to the motivational aspects of WWW sites, we have found that the well-structured use of CGI forms for students to enter their own examples and peer evaluations into a WWW site and see those examples integrated into the site, is motivational for students. However, the degree to which they take this material seriously as study material depends on the degree to which we make them responsible for commenting about it on a test or otherwise give them points for their entries.

- With respect to the motivational aspects of integrating multimedia resources in WWW sites, we have not found the students to be particularly interested in them as enrichments to their study materials. Perhaps it is a longer job than what can occur in one course, or even one generation, but there appears to be a assumption on the part of the students that the "real" study material is what is in "the book", that learning from examples and from external sources is not serious learning, nice, perhaps, but not what counts. We have found a similar reaction to external sites that we have linked to in our study materials; although we choose them with care, students do not seem to take them seriously. They are like the old "Extra for Experts" questions at the end of a chapter in a textbook: who spent time on them? This represents a more-deep seated issue with respect to the use of the WWW and telematics applications in education: Perhaps many of the attributes that we as professionals value most and that we now are pleased that we can more directly make available to our students, such as links to external examples and multimedia extensions or more chances to interact informally with us, are not those attributes that students value or even want, at least in early days in their professional development. And this may not be just a function of immaturity on the part of younger undergraduate students: the question "Is more better?" can be asked of our innovations with media and technologies at every level. We have found in other research that the answer to this question is sometimes "no" [Moonen 1994] [Heeren 1996].

- With respect to course organisation, students very much appreciate a sensible and central way to get practical information and announcements about a course, but would prefer that this was not of a nature that they have to print out in order to remember it and use. If information has to be printed, they would prefer it printed ahead of time and handed to them, even though this would mean we would not have the ability to update the material, to add links to examples, or to add other forms of interactivity such as embedded communication possibilities. The major complaint we have about the integration of all study materials in the ISM-1 course site is that students would much rather have these conveniently assembled in a book rather than having to print them; they value their convenience much more highly than the content-related enrichment offered to them by the special features of the WWW environment. Despite our arguments for the conceptual value of interacting with the course study materials on a weekly basis in ISM-1, there has not been much change in behavior with regard to the students' study habits in this respect. Many of the students wait until shortly before a test to begin to study, and then find computer- and printer bottlenecks infuriating.

- This relates to some of our observations with regard to the development of self-study and self-regulation skills, students do not seem to want to be told how to organize their own work and study timing. They do seem to want to know "precisely" what is expected of them. We have found that to help the students become more self-regulatory, we have used the WWW environment to make self-regulation a required part of the course, i.e., that students must indicate their time and work planning (for a small amount of points) and must report on how well they have met that planning, again, for points within the course, as examples of such strategies. Thus we try to convince the students of the content-related efficency of the self-regulating activities by making these relevant to the final mark itself; we emphasize process in our grading, made systematic and visible via the "Group Planning Pages" in the course WWW site, as well as product and "right answers" on the test.

Conclusion: Revisiting the Hypothesis

Our preliminary hypothesis, based on our analyses of factors affecting student completion of courses, on time and to an adequate standard, was "Productive engagement in a course can be enhanced via applications of the WWW". Given the intervening discussion, should the hypothesis be revisited?

Like all simple statements about cause and effect in complex social systems, the hypothesis is provocative but bound to be inadequate without further contextualisation. We suggest a more focused version of the hypothesis could be:

> "Productive engagement in a course, as a function of heightened motivation, efficient and pragmatic course organization, and improved self-regulating skills can be supported by WWW-based applications, but most important are applications that help students to see the relevance of study materials and activities to their final assessment in a course".

As students mature in their professionalism, the latter emphasis on relationship to the mark given in the course can be gradually replaced by the phrase "..to their professional interests", but this replacement is a function of time and career circumstances and cannot be considered as present in the majority of the current undergraduate students. And even as students do mature in their study habits and internal motivation, the pragmatic aspects of more efficient course organization via WWW-based applications may continue to be perceived as more helpful than the aspects of WWW functionality that relate to enriched study resources or extended opportunities for contact and communication. At least, for several more cohorts of students who have been raised with a conception of good teaching and successful learning that places high value on pragmatic and organizational efficiency..

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Telematic Tools to Support Group Projects in Higher Education

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Abstract: We describe ongoing evaluations and new research on the use of telematic tools to support project work in higher education. Practical experience at our University has shown that project work can be implemented using the World Wide Web for many aspects of the project activities. The possibilities will grow with the introduction of groupware facilities in browsers. Among other success factors, the possibility to implement efficient and effective group and course management is essential for a more broad application of WWW supported project work in higher education. We describe a research project aiming at the integration of project management tools in a WWW environment. We will indicate how such educational tools will differ from project management suites for non-educational organisations.

Project Based Tele-Learning

Project-based tele-learning is defined as problem-oriented learning within the framework of a group project that uses telematics support for at least part of the project activities. Project-based tele-learning is an instructional form of considerable value, particularly at the University of Twente with its institutional commitment to the integration of theory and practical applications in high-level technical education. At the University of Twente many courses are project based. In these courses, groups of 5-15 students work on complex problems. In some of these courses the students have a project room available for many hours per week. In those situations only the support of asynchronous telematic tools is needed. In other courses, instructors and students are more frequently distributed in time or place and thus in increasing need of telematic support, to facilitate more interactions and cooperation among participants, apart from a limited number of lectures and infrequent face-to-face meetings with group members.

Collaborative Aspects

Collaborative learning in a problem-based context emphasizes interactions, where students actively participate in the learning process while solving a problem as a group. Not only problem-specific learning goals are involved in project-based instruction [Blumenfeld et. al. 1991] but also cognitive and social goals. [Van Woerden 1991], for example, notes that project-based instruction in higher education involves: a problem as a starting point, with the need to select and apply subject-specific knowledge for the solution of the problem; the contextualization of the project situation as preparation for further professional practice; the need for optimisation of group-interaction skills; and the development of self-responsibility for one's own learning process. Collaboration, defined as separate and shared responsibilities harmonized toward the attempted goal, is centered to problem-based project work. Collaboration requires more than goal orientation: it also involves attention for the social aspects of group process as well as efficient management and coordination of tests and subproducts [Collis and Smith, 1997].

Tele-Projects at the University of Twente

In general, when WWW-based environments in which starting points for communication, information search, collaborative document processing, presentation and evaluation are integrated, and are used in the support of project work, the results at the University of Twente are positive [Collis 1996]. Evaluations that have been performed [Collis, Andernach and van Diepen, 1996], [Bos, Morgan and Kikstra, 1996] and [Pouw, van der

Veen and Andernach, 1997] of the experiences sofar at the University of Twente support the positive results but note that there are many needs and improvements in project support that are still required. For example, while students note being satisfied with the close collaboration and interdependency that can occur both within and between project groups, problems occur with respect to the efficient and effective management of project work. Improvements are needed in the management of workflow, the organization of group resources, and the extraction and organization of key materials for a "group memory" in such a way that they can easily be shared not only by each set of group members but also by the instructor and members of other groups. WWW-based environments are valued for project support, but if management and communication tools are not integrated within the WWW environments they will loose much of their potential functional benefit.

Problems and Responses

Based on the analysis of project-based courses at the University of Twente, we have identified six major clusters of problems with respect to group-based project work, and the "tele-project" contributions we have so far identified that are valuable responses to those problems based on our experiences with them [Tab. 1].

Persistent Problems in Group-Based Project Work	*"Tele-project" Rresponses*
Problems in maintaining course cohesion and momentum as students become immersed in their respective projects	A course WWW site that integrates study materials, project-work support and communication tools, and through which each groups planning and progress can be visible to all.
Problems in motivating and structuring collaboration	Choice of a task (communal development of a common product) and instructional strategy, the "Jigsaw Methodology", whereby each group member has clear and separate contributions to the group, see for example [McManus and Aiken, 1995]. Choice of the strategy of combining local and distant members in each group.
Problems in motivating and structuring communication	Strategy of having a rapporteur in each group responsible for responding to the instructor during weekly "on-line activities" structured by the instructor. Use of an mail archive derived from newsgroup tools integrated in the course WWW site.
Problems in maintaining a "group memory"	Use of shared workspace functionality integrated in the course WWW site (in particular, the tool "BSCW" made available by GMD, Darmstadt, Germany)
Problems relating to instructor workload	Use of graphic tools to produce WWW pages, and the development of the "Milestone Suite" (described in this article) facilitating the preparation of course planning and automatic status reporting.
Problems in organizing and executing self- and intergroup evaluation	Use of a WWW site as the product as well as the process environment. This allows for inter-group comparisons as well as evaluations based on overall collaborative results. Use of an evaluation tool integrated in the WWW site. This allowes efficient registration of student feedback, immediate comparison among subgroups of students, and visualization to the students of the similarities or differences in their impressions of the course from those of their coursemates.

Table 1: Improving the efficiency and effectiveness of group-based project work: Problems and tele-project responses at the University of Twente.

Tele-Projects in Other Contexts

There are many other examples of tele-project experiences outside of the University of Twente. [Dirckinck-Holmfeld 1995] reports on the implementation of project work with distributed students in a course conducted at the University of Alborg, Denmark. She notes communication problems in group processes, similar to those we experience in tele-projects with limited or no face-to-face contact among participants [Pouw, van der Veen and Andernach, 1997]. In an engineering context [Chinowsky and Goodman, 1997] report that the quantity of communications rises in WWW-supported team-work. They conclude that project-management coordination is still to be improved via new strategies for collaboration, information sharing and project coordination. Michailidis and Rada [1996] give an overview of tools available for the support of collaborative authoring tools with a focus on substantive and annotative group-writing activities. [Spenkelink and Vliem 1997] report about the educational use of the shared workspace BSCW, initially set up for research communities. The shared workspace functions well as a group memory, if the workspace is under control of the group, the structure is kept simple and emotionally loaded comments are directed through more private channels such as Email or telephone, thus protecting the addressed from 'public' exposure to criticism. In contrast [Rada 1996] reports limited use by students of shared workspaces. He finds that students seem to prefer to use plain HTML-pages for an overview of the work to be done.

From a review of experiences in the literature as well as our own, we have come to the conclusion that project-management aspects of group work are a relatively weak aspect in both practice and literature. We are thus focusing particular attention in this direction.

Project Management in Project Based Tele-Learning

The management aspect of project based group work is especially important when distributed instructors and/or students are involved in the collaboration. Many combinations of remote and co-present participants exist, for example, a number of distant guest lecturers can be involved in the tutoring of a course. Some students might be involved in projects performed by campus based project groups elsewhere. Other forms are bilocated groups of students in international university cooperation projects. In any of these combinations, project management is important.

Project Management and Tools

From the instructor's point of view the management aspects in project-based group work includes having a good and convenient overview of the progress of all groups, and having effective channels for giving content feedback and remarks with respect to the group's progress. For the project groups, management of the group's interrelated processes is important, especially with larger groups. All group members should have a clear common overview of tasks, deadlines and who is responsible for what. If process-related tasks in the groups are assigned to group members, those responsible for management will, like the instructor, feel the need for an overview of the group process and progress.

For both instructors and group members, management of group (partial) products, and easy access to these products is also important in facilitating their work. Altogether, it appears that a combination of a shared workspace, a workflow tool and integrated communication facilities would facilitate group work best. Convenient ways to link group progress indicators with relevant course study materials, and lecture notes would also enrich the project group virtual work environment.

Examples of Project Management in Tele-Projects at the University of Twente

In the Educational Science and Technology course "Instrumentation Technology 1" for first-year students at the University of Twente, extensive use of WWW functions is made to support the project work of the course and, to link this project work to other course elements [Collis 1996]. The planning for the groups is set by the instructor and visualised in tables with columns for *task, person responsible, deadline* and *status*. As most deliverables are in HTML-format, they are linked from this table when completed, thus facilitating group memory and, both instructor and intergroup evaluation. The "Applications of Information Technology" course, part of the Business and Information Technology curriculum, offers first-year students project work in groups composed of Dutch and Finnish students [Pouw, van der Veen and Andernach, 1997]. In this course the groups have to do their own planning, to be commented upon by the instructor. The planning is captured in HTML-format and available through a link from the so-called GroupCentre table in the course WWW site. In the "Working in Project Teams" course, groups of third-year students of all disciplines work on a design project, using a shared workspace as group memory. The student management of the group uses the software product MS Project to produce a Gantt chart indicating tasks and their interrelations. As part of a Word document this chart is available from the shared workspace for all students and instructors.

"Project Suppport" and "Milestone Suite"

Based on the particular analysis of the experiences and needs associated with project management in courses in Web-based environments, it has become clear that an integrated support is needed, combing the different needs for telematic support. This integrated design, called Project Support, will try to fulfill this need. In the development of Project Support new available functionalities can and will be incorporated. The Milestone Suite will fill in the need for project management both as a support for the instructor and the student members of the project group.

Project Support

In this section, we briefly describe the functionalities of the Suite, the desing approach and the architecture. In "Project Support" we are giving particular attention to the efficient support of high-speed communication, efficient and effective access to appropriate (multi-media) information, and management of group processes and group memory. The Project Support environment will integrate the contributions identified in [Tab.1] with new developments made possible by improved network technology and emerging WWW-based possibilities. In particular we are studying the integration of support for real-time communication during group work when group members are in different locations, and the integration of multimedia databases to link the theory and practice of the courses via examples and other resources.

The approach of the research is one of rapid prototyping, incorporating systematic modelling at several abstraction levels, intertwined and advanced by on-going evaluation. In this evaluation we will work to find out how learners and instructors use telematic support tools. Questions we are asking include: Do advanced telematic tools have an added value for the educational process or will they lead to loss of efficiency due to the number of telematic-based facilities that are difficult to control ? A set of modules for project management is being prototyped. We call this the "Milestone Suite".

Design approach for Milestone Suite

In our research project we are focusing on the group management aspects. Our idea is that a 'Milestone Suite' can make life easier for both instructor and student group management. The final implementation will be closely related to the other elements of Project Support, as described in the previous paragraph. Issues to be addressed by the 'Milestone Suite' are:

- How can the instructor easily set up a "milestone planning", to be refined by the project groups ?
- How can status reports be generated automatically giving an overview of the progress to both instructors and group management ?
- How can instructors and group managers give educationally relevant feedback directly to those involved in tasks that require intervention ?

Giving these requirements, it is clear that in our project we will be modeling and testing tools for a distributed tele-learning community. We will do so, from three different viewpoints:

- From the educational science point of view we will use instructional strategies to give us directions on the design of this sort of tele-project education [Collis 1996].

- The formal description techniques available from computer science will be used to model the distributed environment and services needed [Moonen, Michiels, Collis, Widya, 1996], [Volman et al., 1996].
- From the university 'workfloor' we will use the outcomes of ongoing evaluations of tele-learning courses, especially from those courses with distributed learners involved.

Global Architecture

The main modules of the milestone suite are, see also [Fig. 1]:

- DataEntry: Student, group, and instructor data are entered from data sources delivered by the departmental office.
- MileDefiner: The fixed course deadlines, and milestones such as main aspects of a workplan and presentation deadlines are set on a timeline by the instructor. The instructor specifies attributes like EndDate, DeliverableType, DeliverableName, Assignees, etcetera. Also procedural guidance can be made available behind icons on the same timeline. On a second timeline the group can visualise its own group planning.
- MileChecker: When the instructor or the group manager wants an overview of the progress sofar, MileChecker can automatically check if the deliverables are indeed delivered.
- MileReport: The status reports are made to give the instructor an overview of the progress of all groups, as well as an entry point for easy access to the deliverables to be commented upon or assessed. Default feedback texts can be tailored to suit the instructor's needs when sending a message to a group.

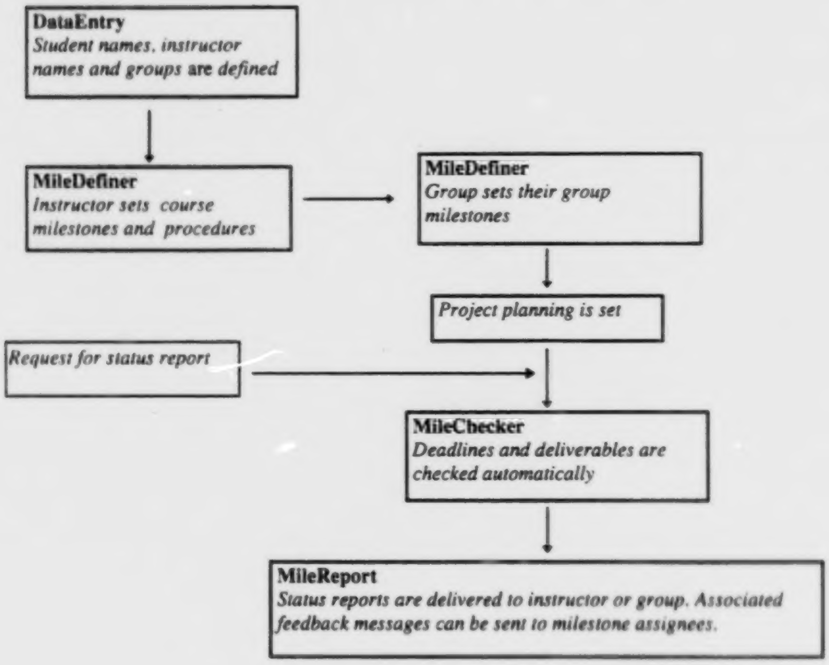
DataEntry
Student names, instructor names and groups are defined
MileDefiner
Instructor sets course milestones and procedures
MileDefiner
Group sets their group milestones
Project planning is set
Request for status report
MileChecker
Deadlines and deliverables are checked automatically
MileReport
Status reports are delivered to instructor or group. Associated feedback messages can be sent to milestone assignees.

Figure 1: Global architecture of the Milestone Suite modules.

Discussion : Project Management in the Workplace and the Learning Setting

In preparing students for professional careers, we think it is important that students get experience in working together with fellow students using telematic support. For project-based tele-learning we are giving particular attention to how telematic support can facilitate the collaborative work of distributed learners. We have shown that project work can benefit when supported by a Web-site. Integration of the telematic support functions, communication, memory, workflow and group management will give tele-project education a strong tool. When implementing these functions we will be using mainstream Web-browser technology, combined with tailored software in an integrated, for the users transparent way. Finally, a good educational strategy and a good communication protocol will remain essential ingredients for successful courses using such tools.

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Why Computers Are Transforming the Meaning of Education[1]

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1. Introduction

The rise of networked computers through the Internet has inspired very different interpretations. Some see it as merely the next step in a long evolution. They note that global communications are not new; that Alexander the Great prepared the way with his pony express linking India with Europe in the fourth century B. C. In this view, the spread of the telegraph and the telephone in the nineteenth century and television in the twentieth century were preparatory stages for the multimedia evolution now underway.[2] Some see networked knowledge merely as an industry driven enterprise.[3] A third view sees the developments of the past decades as the beginnings of a revolution of monumental proportions,[4] a view for which this paper will explore further evidence.

By way of introduction, basic changes in capture and display methods are mentioned. The scope of new content that is becoming accessible is explored, as are the implications of access to these sources in a distributed knowledge framework with respect to collaboration and augmented intelligence. A fundamental development entailing the separation of content and presentation is outlined, as are its implications for the rise of meta-data, agents, delegation of work and the re-definition of learning.

2. Capture and Display

In the past images were captured mainly through two-dimensional photographs Some imagine that computers will merely reproduce these images on their screens, in which case it would simply be a case of translating analogue images to a digital form. Recent developments in technology mean that much more is entailed. First, new cameras (e.g. the Vasari scanner, London) permit scanning at rates of c. 1.4 gigabytes per square meter resulting in much higher resolution than available in ordinary photographs. Second, new laser scanners (e.g. NRC, Ottawa) permit capture of images in three-dimensions such that one can see surface details such as brush strokes, cracks, even subtle surface layers of a painting. In the case of sculptures and museum objects one can produce images in the round which can be rotated on screen such that one can see all sides of the object. Stereoscopic images of these objects can also be created and viewed through lightweight stereo-glasses. Through new methods of stereo-lithography one can effectively reproduce three dimensional sculptures and objects on demand. Third, recent developments in x-ray technology permit one to view different layers of a painting, thus allowing one to trace different stages in the artistic process.

With respect to display of images recent breakthroughs in imaging technology permit one to zoom seamlessly from a distant to a detailed view of a painting. At the high level this requires a gigabyte (of RAM) and an SGI Infinite Reality Engine, as seen in Infobyte's reconstruction of the *Stanze* of Raphael.[5] Hewlett Packard has developed a mid-range version of this technology called Flash Pix and the developer of Apple's Quick Time V-R has produced a low-end version of the same principle called Real V-R. Traditional images were static. The new technologies render these images dynamic and allow the viewer to focus in or move back at will. Such dynamic images challenge the viewer to become more actively engaged in the experience of looking at pictures.

Considerable work is being done on stereoscopic displays in the context of high definition television (HDTV). Another trend is to produce auto-stereoscopic images, which do not require head mounted displays or even glasses and appear as three-dimensional images suspended in space. The net result of such developments is that they frequently allow us to see more through electronic images than we could see in the case of the original object. Thus new methods of display and capture are in fact redefining the very meaning of content with respect to the originals.

3. Distributed Content

In the past, access to materials was limited by those which happened to be available in one's local site. If one had the good fortune to be in a city with a major library such as London, Paris or Rome one had many more resources than if one lived in a village or on a farm. The rise of Inter-Library Loan expanded these horizons considerably on the basis of individual items one at a time. The rise of the Internet saw the emergence of major national networks such as BLAISE (Britain), PICA (Netherlands and Northern Germany) and international networks such as the Research Libraries Information Network (RLIN, which now has over 100 million titles). More recently basic texts linked with the reference section in libraries (dictionaries, encyclopaedias etc.) have been entered electronically and a series of initiatives have begun scanning in the full texts of sections of major libraries. Some of these have been led by major corporations. For instance, IBM is scanning in the Vatican Library, the Luther Library at Wittemberg, and the Edo Museum in Tokyo. Xerox is scanning in the Gregorian Library. In the United States there is a national initiative for digital libraries, which to date involves at least ten projects.[16]

A number of individual museums and galleries have also scanned their complete collections of images, including the national galleries in London, Edinburgh, Ottawa and Washington and collections such as the Louvre (Paris), Uffizi (Florence) and Pushkin (St. Petersburg). Two approaches are emerging. In the United States a short term, pragmatic view dominates. In Washington, for instance, the National Gallery is scanning in its 105,000 images at 30 megabytes an image. In Europe, there is more concern that these images be scanned in once for the long term and at a level such that they can serve the demanding needs of conservators for collaborative, on-line restoration of paintings. Hence, the National Gallery of England is scanning in its images at c.100 megabytes per painting. They have also produced a lower level CD-ROM which has already sold 55,000 copies. The Uffizi, using the Vasari camera mentioned earlier, is scanning its images at 1.4 gigabytes per square meter.

These individual efforts are becoming linked with more global initiatives on a number of fronts. In North America, there are private efforts such as Project Gutenberg and larger initiatives combining private and public sectors such as the Text Entering Initiative (TEI) and the Coalition for Networked Information, which is planning to scan in 10 million books in full text. These projects fit into an American vision, which has both positive features and limitations. Very positive and laudable is their assumption that a basic level of these images would be universally accessible, to all citizens whether or not they are impaired in terms of sight, hearing or speech. Their great optimism about the feasibility of a universal databank of all human culture comes partly from seriously underestimating the scope of the challenge. A keynote speaker at the Sixth International World Wide Web Conference recently (April 1997) estimated that there were 100 million documents in the world. They were not aware that the RLIN database alone has that many titles or that a recent report of the European Commission based on the 75,000 major libraries of Europe (excluding archives), recorded 2.2 (European) billion books, (i.e. 22 times speaker's estimate for the whole world).

Meanwhile in Europe, the European Commission (EC) has introduced a Memorandum of Understanding (MOU) for Multimedia Access to European Cultural Heritage. This includes 282 museums and galleries, 25 governments and regional government organisations, 10 communications service/software companies, 2 Telecom/CATV operators, 22 IT-Telecom equipment companies, 22 members of the new media industry and 24 non-governmental organisations. The goal of the MOU is that by the year 2000, fifty percent of these major collections will be available in electronic form and lead to cultural industries in a new sense.

To this end, the European Commission, within the context of its Advanced Communication Technologies and Services (ACTS) is sponsoring a series of research and technology development projects in three areas: i) interoperability; ii) IPR protection and conditional access, and iii) advanced multimedia imaging, presentation, 3D and virtual presence. The budget for these research projects alone is ECU 812

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million. In addition, with a view to practical deployment and dissemination the Commission is sponsoring projects under five other initiatives, namely: i) Trans European Networks (TEN) for Telecommunications; ii) INFO 2000; iii) Raphael iv) structural funds under the European Regional Development Fund (ERDF) and v) the Euro-Mediterranean Partnership (MEDA). Some of these themes will be pursued with a greater emphasis on content within the fifth framework (1999-2004).

At the global level, the Bangemann Report inspired the G7 Information Society Exhibition (Brussels, February,1995). This prompted the seven leading economic countries of the world to initiate eleven pilot projects among which are education (pilot project 3), libraries (or Bibliotheca Universalis, pilot project 4) and museums (or Multi-media Access to World Cultural Heritage, pilot project 5). Efforts are underway to co-ordinate the MOU initiatives at the European level with those of the G7 at the global level. For instance, the MOSAIC project within the TEN framework is being proposed as a participant in G7 pilot project 5. There is also some discussion of creating a common front-end for all eleven of the G7 pilot projects.

Very few persons have understood fully the implications of these developments for problems of bandwidth on the Internet. Traditionally the typical connect time for a (voice) telephone call was c. 3.5. minutes. In 1996, the average connect time for a typical user of the Internet was estimated at approximately 35 minutes. There is now much discussion about the advent of the Network Computer (NC). Implicit in this arrangement is that the user needs to be on-line continually. For an average employee that would be eight hours per day. Let us assume that a typical user makes six calls a day, which would be about 21 minutes of connect time. Even an elementary knowledge of mathematics suffices to realize that if the estimated 40 million users all changed their demands from 21 minutes to 480 minutes there would be nearly a twenty-threefold increase in connect time. The use of stereoscopic HDTV, mentioned earlier, would require c. 55 megabits/second, and again dramatically increase the demands.

At present, a typical private user has a 28,800 baud connection. Operational research networks such as the Tuscany MAN, the Canadian Advanced Network for Research Industry and Education (CANARIE) and the U.S. Very high Bandwidth Network (VhBN) are operating at speeds between 45 megabits/second (OC3) and 155 megabits with a view to moving to 622 megabits/second. In April,1997, Pacific Bell introduced commercial services at 270 megabits/second. Meanwhile at an experimental level Nortel has already done a test demonstration at 6.2 megabits/second (OC 192). There is discussion of terabyte networks. The details of such numbers are not important for our purpose, which is to make a fundamental point. The network(-ed) computer revolution is something much more than a simple re-use of our old telephone and television lines. We need to re-connect the world with new networks of wires, and frequently in some combination with wireless modes. Establishing this network will be one of the major growth areas for the next generation. Maintaining this network will be a more lasting source of employment and business.

4. Distributed Views and Collaboration

One of the initial inspirations behind the Internet was not so much the simple on-line access to materials, but rather the possibility of being able to share distributed views at a distance through collaborative work. In 1952, some forty-five years ago, Douglas Englebart, the visionary pioneer who invented the mouse foresaw i) a version of e-mail which would be hyper-linked with ii) shared files, iii) a journal (library) and iv) external (offline) documents.[7] Engelbart's original vision centres on five words, Concurrently Developing, Integrating and Applying Knowledge, a process which he abbreviates to a single term, CODIAK.[8] This process, which comes from a direct sharing of information would be impossible in earlier learning environments such as a traditional (unwired) classroom, a library or a museum. Engelbart sees this process as the basis of an augmented intelligence.

In terms of profession and personality, Douglas Engelbart is worlds apart from Howard Rheingold, the author of *Virtual Reality*[9] and *Virtual Community*,[10] a founder of the WELL, of *Hot Wired* and more recently, *Electric Minds*. In terms of basic approach, however, there are some striking similarities. Rheingold, for instance, tells a story of an event that convinced his wife of the value of his seemingly excessive "surfing." One evening, their daughter was inflicted by a tic. His wife rushed out to find a doctor. Howard went on line and asked for help. Before the doctor had arrived someone on the web had provided necessary knowledge about what to do under the circumstances. At a very practical level this is an excellent illustration of augmented intelligence as described by Engelbart.

It is instructive to note that these views of augmented intelligence are very distinct from notions of collective intelligence, which have been popularised by other recent authors (e.g. Levy[11]). Augmented intelligence is about persons sharing their particular knowledge to arrive at new insights. It is about the development and deepening of individual personalities. They may work together. They may form teams but they remain individuals. Indeed their individuality grows in the process. Collective intelligence, by contrast, implies that the intelligence lies abstractly in a collective group rather than in a concrete individual. In this view the individual as such is implicitly flawed until they are networked in a group which is somehow the locus of this elusive new intelligence. In this view the group is more important than the individual and in some mysterious way the collaborative efforts of the group are held to be more valid than those of an individual on their own. Those who study history may see more than passing resemblances between these two approaches to intelligence and the debates of a century earlier between Kierkegaard (the individual is the locus of truth and development) and Marx (the group or masses are the locus of truth and development). Students of history may also remember the pitfalls of setting groups above individuals encountered in the 1930's.

Augmented intelligence, in Rheingold's view --and implicitly Engelbart's also--, entails a web, which is much more like a telephone than a television: i.e. it is an active experience for sharing and collaboration rather than simply a passive object which provides one with information pre-sorted by someone else. This is rather strikingly different from an emerging market driven view of the web, which typically speaks of cultural industries and collective intelligence. One is tempted to dismiss these differences as merely academic distinctions. It is true the extreme version of the exclusively market driven view is more prevalent in universities than in the frontiers of high industry. Nonetheless, the implications of this view are anything but academic. On the industry side its proponents almost invariably speak of (active) information service providers and (passive) consumers. Rhetorical reference may be made to interactivity, but only in the sense of passive users following choices made by active producers and providers. In academia, the most extreme proponents of this view pretend that business school is highest in the echelons of (academic) subjects and that only projects which bring in money are legitimate, as if scholarship were a straightforward money making proposition. More subtle proponents of this view favour collaboration almost for its own sake. In education this is especially true of the constructivist school, who hold that learning is essentially about creating world views which they believe is fostered by collaborative work. They see the work of groups as more important than the solid thought, reflection and writing of individuals. Hence those who do work in groups are favoured over those who work in "isolation."

Underlying the differences between augmented and collective intelligence are, in fact, two competing views of the web and its functions. At first sight, it might seem that this conflict is a simple one between realists who recognise the importance of economic facts, and idealists who have forgotten that they are living in the real world. It is important to realize that the real battle lies elsewhere. It is not a question of economics vs. an uneconomical approach but rather a battle between an exclusively market driven view and a gift economy. Extreme versions of the market driven view depart from a two-fold business case scenario which a) believes that everything can be reduced to a business proposition in the form of a transaction or b) that one can at least control everything through licenses which are bought. Unfortunately these assumptions do not apply to culture.

In geometry, one of the ways to proof is to assume that a given claim is true and then follow its consequences until the absurdity of the argument reveals itself. Applied to the topic at hand, this approach might run as follows. Business case one assumes that everything can be bought and hence everything has a price. On the surface this is right. One can point, for instance to a very famous manuscript such as the *Evangel* of Henry the Lion, which was auctioned in London a few years ago for over eight million pounds. This manuscript is now shared by the Herzog August Bibliothek in Wolfenbüttel and the Bayerische Staatsbibliothek in Munich. The library of Duke August of Lower Saxony was once the greatest in the world and has had Leibniz and Lessing among its librarians. It has c.12,000 manuscripts and c. 810,000 books, many of them unique copies. The *Evangel* is a special case. At our hypothetical bargaining table we could agree that the average cost of a precious manuscript is much less than the *Evangel*, say one million dollars. The cost of the manuscripts at the Duke August Library would thus be 12 (U.S.) billion dollars. Books are much less expensive. Some may be ephemera. Some books such as a Gutenberg *Bible* can easily be worth a million for a single volume. At our bargaining table we might decide on a bargain price of a 10,000 dollar average per book. The 810,000 volumes would thus be available for a mere 8.2 (U.S.) billion. The manuscripts and books together [12]would cost 20.2 (U.S.) billion. In addition, there are also some 20,000 maps, 26,000 portraits, 950 precious books hand painted by some of the most famous painters of the twentieth century, archival materials, a music collection, a reference collection of 210,000 books. These are all housed in three buildings one of which is a unique historical monument, another of which was the former home of one of Germany's greatest poets. In the interests of brevity these might be lumped together for an additional 4.8 (U.S.) billion, which means that this single famous library would be available for a round sum of 25 (U.S.) billion. This amount is close to the price paid for some of the most dramatic mergers of the past decade, which are also the greatest mergers in history.

In the corporate world, mergers typically occur between two giants in a field where the number of others is seldom more than a half dozen. In the world of culture, matters are very different as becomes clear if we pursue our argument. The Vatican Library, for instance, has c.150,000 manuscripts. These are no less precious than those of Wolfenbüttel. By the market standards established above, the Vatican's manuscript collection could theoretically be bought for 150 billion dollars. Its million books would readily be worth another 20 billion and the secret archives would easily be worth another 30. The map collections, decrees, coins and other artefacts in the library would make another 100. That makes 300 for the library alone, which is part of a much larger complex. Saint Peter's with its inestimable treasures would readily be worth another 300. The Sistine Chapel could fetch 50 as could the Stanze of Raphael and the Borgia Apartments. The painting gallery would easily be worth another 100, as would the Ancient sculptures. Lesser collections such as the Egyptian, the Etruscan, the Chinese might go at 50 each. Even omitting the great hall of maps, the halls of tapestries, and other church objects, the Pope's apartments, the other administrative rooms of the College of Cardinals, the gardens, or the great courtyard and balustrade of Bernini, the radio station, the quarters of the Swiss guards, we have arrived at a figure of 1.15 (U.S.) trillion dollars. Hence a serious offer for the whole complex would need to be at least 2 trillion (U.S.) dollars. As a single expense this exceeds the budget of any corporation and even any government. In the context of Rome, however, the Vatican does not comprise even 1000th of all the treasures of the eternal city. At a conservative estimate therefore, serious bidding for the culture of Rome alone could begin at a sum above 2,000 (U.S.) trillion dollars. The culture of Rome does not amount to a 1,000th of the whole of Italy even if one limits one's horizons to high culture. So a reasonable bid for Italian culture might begin at a sum above 2,000,000 trillion U.S. dollars. Small wonder then that an individual who paid over 30 million for 72 of Leonardo's 6,500 pages was not taken seriously when he offered 2 billion for the images of French culture, which does not deem itself to be inferior to Italy. The point of this excursus is a simple one. Even if everything could be bought, we would rapidly have to conclude that no individual, no corporation, no consortium or even the richest government could even attempt to consider purchasing the cultural heritage of even a single, major European country, let alone the world as a whole. This is a domain where notions of possession, take-over bids and stock options will not work. The notion of buying content may apply to evanescent films but it cannot apply to culture.

Having conceded that we cannot own everything,[13] business case two assumes that licensing for control is the answer. Licenses are typically some fraction of the full cost for a limited term of say five years. In the business world, a license for one percent of the original would be very conservative. Keeping with our hypothetical assessment above, a license for the whole of Italian culture would thus amount to a mere 20,000 trillion U.S. dollars, payable once every five years, which is still considerably beyond the budgets of even the biggest players. In short, the extreme view of business whereby everything can be either bought or licensed cannot apply to culture. It is a myth.

That business cannot own or control culture, does not exclude their working together. If business invests x dollars in scanning the images of a museum, they can fairly expect that when the museum makes money from the resulting electronic images, then the business will be re-imbursed. Business will have indirect incentives for doing so also. Cultural content has great appeal. Almost everyone has some interest in Leonardo's *Mona Lisa*, or Michelangelo's David, or at least would have us believe that they are. With a greater amount of culture more persons will need computers and more persons will use Internet lines (phone, cable, wireless etc) in order to connect with great repositories of culture. Culture provides one of the whys for the products of computer firms and telcos.

This scenario becomes even more attractive if viewing low level versions of the images is available at no costs (other than the transmission) and payment is associated with detailed versions, printouts as postcards, posters, slides, sculptures on demand, special interpretative projects (e.g. films) as well as obvious adaptations for advertising. Once the content is available and there are tools for its publication and interpretation, then there are large new markets for machines and pipelines, and new services in terms of training and maintenance. Some clues for reaching this goal may lie in what appeared at first to be an opposing view.

If the view espoused by Engelbart and Rheingold could seem overly idealistic and ultimately unrealistic, it should be noted that one of its most articulate champions is also one of the paragons of capitalistic, entrepreneurial, free-market business, namely, Apple Computers. Some of the leading spirits at Apple note that Apache, one of the best examples of server software available today is a result of volunteer co-operation rather than from a commercial company and is available free of charge. They also point out that when Apple was developing the programming language, Smalltalk, they came to an impasse due to lack of funds. An estimated two million dollars would have been needed. They decided to make the code freely available and within six weeks, volunteers had accomplished without money that which had seemed economically impossible.

Such experiences led Apple consciously to contrast a narrow, strictly market driven, money economy view with their notion of an educational object economy, which as they are well aware, is based on the principles of a gift economy. Their idea is simple: create an Apple Application Tool Kit, which would effectively serve as the first letters of a software alphabet. A user wishing to adapt letters *a*, *b* and *c* of that alphabet with their own letters *d* and *e* in order to create a new product, would be at liberty to use them at no cost. The proviso would be that they submit the resulting product in the free repository. On the other hand, persons wishing to charge for their results would be charged proportionately for the pieces they acquired from the repository.

The Apple initiative can be seen as part of a larger global trend. Visionaries at Apple such as Steve Cisler, are actively studying the phenomenon of communities, not just the virtual communities of which Rheingold speaks, but the underlying principles which inspire persons to work together. This topic also being studied by the (Marshall McLuhan) Global Village Conference (Franz Nahrada, Vienna), which is becoming a focal point for the emerging field of intentional communities, namely, groups of persons who have deliberately chosen to live in a place rather than simply moving into a neighbourhood by chance.

At the same time the Apple approach relates to the philosophy of freeware on the Net, as in the GNU[14] project of the Free Software Foundation. It consciously builds on principles introduced by some of the developers of Java applets[15] and relates closely to a growing trend toward open standards. Ironically, Apple which initially began in opposition to the legacy systems approach of the old IBM, went on to develop its own proprietary software. IBM then played a key role in founding the Object Management Group (OMG), which developed the Common Object Request Broker Language (CORBA). The Open Group (which sponsors the Open Software Foundation, and the X/Open Group), the Open GIS Consortium, the Open Microprocessor Initiative, the Office of Open Information Interchange (OII), the World Wide Web (W3) Consortium and G7 pilot project 2, Global Interoperability, have the same stated aims. A next challenge lies in all these bodies agreeing on a single corpus of core standards, which will make the universality of the Web a reality.

When we use a telephone, we think of it as hardware. Actually it is both hardware and software. Yet we never think of buying another software package every time we want a new feature. We pay a standard rate and then more for features. Needed is a consortium between the telcos, computer manufacturers, television companies and other players to produce a set of tools which work seamlessly. In the case of digital television[16] there is talk of a 10-20 year transition period in moving form analogue to digital methods. If we begin now with practical tests involving actual users in classrooms and research sites as well as in trial homes, then a universally acceptable and useful interface can evolve in pace with the transition.

As for the new content that is needed, it is instructive, in this context, to recall that the great breakthroughs in content production during the Renaissance would almost certainly have been impossible if tens of thousands of monks working in mediaeval monasteries had not spent centuries preparing source materials in intentional communities on a volunteer basis. In the Middle Ages, these extraordinary efforts were possible because a great percentage of the population was effectively unemployed. A number of futurists are predicting a similar trend towards unemployment in the near future.[17]

One of the most dramatic of these scenarios was explored in November of 1995 in a meeting with 500 world leaders organised by Michael Gorbachev (San Francisco). Here the claim was made that, with advances in technology, within a generation 20% of the population will be employed doing regular jobs and 80% will be unemployed. Their proposed solution was that these new masses of unemployed be distracted with a variant of the Roman tradition of bread and circuses with sex added, "tittytainment".[18] While, it is tempting to dismiss this merely as excessive pessimism, wrapped in bad taste, it is sobering to note that the non-fiction account of the meeting has become a best seller in Austria and Germany and very much *a cause célèbre*. A much more attractive scenario would be a revival of the learning dimensions of the monastic tradition without the dogmatic excesses. Thus one could use an enormous new voluntary work force to arrive at new organization, interpretations and insights concerning culture which will be of benefit to all.

Such a revival of monasticism could also address another fundamental problem. Thus far much of computer software has been designed for business activities which did not exist prior to computers, work flow diagrams, new levels of financial planning, retirement programs and the like. They are sold on the pretext of saving time. Unfortunately they computers save time with respect to distractions they have in turn created. Where are the programs that help us gain serious access to world knowledge, help us to understand the reasons for alternative explanations to truth, philosophical insight or religious inspiration? For economic reasons, computers have addressed business needs more than human ones. A revival along monastic lines could redress the balance.

5. Separation of Content and Presentation

In the world of books there has been a traditional separation between the process of writing the content of a book (author) and the presentation tasks in preparing it for publication (layout person, typographer, editor, publisher, printer). Even so the product of these efforts was traditionally a book in which these processes of content (creation) and presentation were intertwined. In the 1960's and 1970's, those at the frontiers of electronic editing recognized that in the new medium these two processes could be treated as separate functions. To this end a Standardised General Markup Language (SGML) was developed.[19] This became a standard for scholarly groups such as the Oxford Text Initiative and the Text Encoding Initiative (TEI) and was adopted by major document management firms such as Xerox and Intergraph.

Critics complained that SGML was unnecessarily complex. To an extent they were right. SGML was designed for dealing with the complexities of a) high-level scholarly publishing (footnotes, diacritics, accents, special characters in Old English, multiple notations) and b) the sheer volume of a major corporation such as Boeing, which produces manuals weighing more tons than the 747s they describe could lift. These tasks require(d) subtleties well beyond an average user's needs. Hypertext Markup Language (HTML) offered an alternative much closer to these everyday needs and enjoyed a meteoric rise. HTML was also an informal stopgap measure rather than a methodical solution. It conflated the distinction between content and presentation which SGML had laboriously distinguished.[20] The World Wide Web (W3) Consortium is committed to provide more felicitous solutions. Those with complex needs will continue to use SGML. For those with everyday needs, the team at W3 is creating a simplified version of SGML called XML (Extensible Markup Language). To meet the different presentation needs the team is developing cascading style sheets. In the near future it will be possible to have a single content document, which can then be presented and published in the form of many different "views", including versions accessible to those impaired visually, vocally or aurally.

In the short term, the W3 Consortium is working with industry partners to produce tools for four specific markets: web publishing, intranets, electronic commerce and education which includes training. The vision of Tim Berners-Lee is that fulfilling these short-term needs will help realize the long-term goals of personal empowerment, social efficiency, understanding and harmony and exploiting computing power in everyday life to solve problems and augment the capacities of persons.

6. Meta-Data

These tools entail much more than easier and faster ways of producing web pages. They entail new methods for getting at the already enormous mass of information existing on the web which is increasing daily. The earliest search engines either surveyed URLs or searched the full contents of the web-site. The first of these strategies was typically too imprecise or summary. The second strategy is increasingly too cumbersome. Browsers provided an alternative approach by creating personal classifications of terms in hierarchical lists as an intermediate step to searching materials. Until recently there was a clear distinction between search engines and browsers. A search engine such as Altavista allowed a user to choose a term, which would produce a number of hits. A browser such as Yahoo allowed a reader to browse through predetermined lists of subjects hierarchically arranged, choose a term and then call up the associated hits. More recently new tools such as Infoseek,[21] and Webcompass [22] are combining the features of search engines and browsers. A reader types in a term. The search engine finds a series of hits and also a series of related topics, which can be browsed in order to arrive at further hits. The Stanford Digital Libraries Project[23] is developing this approach with new tools such as SenseMaker.[24] These are but isolated examples of a larger picture.[25]

1.	2.	3.	4.	5.	6.	- 7.	8.
URL, URN, URI ISBD-ER	MIME Types	Site-Mapping	Content Mapping	Abstracts	Library Meta-data	- Content - Negotiation	PICS

Figure 1. Eight ways in which information about information is helping the quest for understanding on-line materials

New tools are focussing on providing information about information, generally termed meta-data, tagging original documents to produce the equivalents of brief summaries, such that search tools can scan these without having to read the full contents at every turn. These include at least eight different kinds of initiatives (fig. 1), which range from short term stop-gap measures to long term solutions. The most basic of these entails adding greater precision to the initial header to the information. One initiative, led by the W3 Consortium, entails supplementing the convention of a Uniform Resource Locator (URL) with a Uniform Resource Name (URN) and a Uniform Resource Indicator (URI). Meanwhile, the library world is creating an International Standard Bibliographic Description for Electronic Resources (ISBD-ER).

A second step, in which Xerox is playing a significant role, entails a more systematic definition of media types, or MIME types. Suppose, for instance, that a user is searching for databases on ecology. Assuming that databases are identified as a media type, then a search can go directly to sites with databases and can skip all other sites where databases are lacking.

A third initiative, involves some measure of quantification using visual tools. To this end, James Pitgow, a student at Georgia Tech, --now at Xerox PARC--, developed a method of mapping the links between a home-page and the hierarchies of topics connected therewith, inclusive of hyperlinks among sections such that one can discern which pages are crucial in any given site. This permits one to see at a glance whether the home page is merely a façade to a few random pages or an entry point to a large body of systematically organised material. This concept of site-mapping will soon appear as a new product of Microsoft.

Related to this is a fourth action, which might be called content-mapping. In the case of databases, this would gather data about the parameters or constraints of the information contained therein. This might, for instance, explain the temporal limits of the materials, that it is only between 1850 and the present; or the geographical boundaries, that it covers only North American materials. Such constraints will also become part of search strategies. For example, when one specifically wants news about Amsterdam, then it would make sense for a search engine to focus on what resources Amsterdam has to offer rather than searching all the web sites on the other four continents at the outset.[26]

A fifth set of steps entails tools to provide automatic abstracts of content. For example, as part of its Application Tool Kit, Apple is working on a product called Vespa, which will serve as an editorial aid for summarising documents. Special algorithms will allow one to have a one page summary, a one paragraph abstract or even a single sentence outline of an article. They are also developing a product called *Hot Sauce*, already on the web,[27] which allows hyperbolic hypertextual linking and editing. In the longer term such initiatives relate to a bigger picture being developed at Xerox, which distinguishes between four elements: the infosphere, workspace, sense making tools and the document. Xerox PARC is working on various new methods of information visualisation.[28] Some immediate implementations are being spun off through a new company termed Inxight, while they continue to work towards a long-term solution. They have, for instance, developed search strategies using a scatter-gather method, which go beyond the simple keyword searches prevalent today. Another group in Grenoble is focussing on digital library solutions.

Loosely speaking all five of the initiatives listed above can relate to meta-data in general, i.e. producing information about information. A sixth set of initiatives, which we can term library meta-data is building on the cumulative experience of the library world and scholarship. In 1995, the Online Computer Library Company (OCLC, Dublin, Ohio), in conjunction with the National Center for Supercomputing Application (NCSA, Urbana-Champaign), organised a first meta-data conference. This resulted in the so-called Dublin Core[29], a set of twenty essential terms (names of fields in databases), whereby libraries could share data about their data, effectively creating the potential for interoperable pointers to works and their contents.

A second meeting in Warwick, England[30], (1996), produced "the Warwick Framework: a container architecture for aggregating sets of meta-data."[31] This discussed more closely the problem of interoperability between different catalogues, which may use alternate words for the same term. For instance, one library may have a field for "Author", whereas a second library has a field for "Name," while a third has a field for "Artist." A person searching from a remote site for literature on Michelangelo has no interest in checking what the variant heading happens to be in different libraries. They simply want the system to search seamlessly in the appropriate fields to acquire the relevant literature. The Warwick framework raised awareness of this problem and prepared the way for a solution.

A third meeting in Canberra (March 1997), focussed on three items:1) a syntax for element refinement; 2) a scheme to record how this term is encoded, e.g. the Library of Congress Subject Headings (LCSH or MESH which could potentially permit links to different classification schemes) and 3) a tag to qualify in what language it is. Participants of these meetings span a large range of individuals from the library world, major industry and governmental institutions. Taken together these initiatives for meta-data promise a new set of intermediary records which will be the equivalent of abstracts on the Web so that we do not have to crawl literally through the full texts of documents which may not interest us.

A seventh set of initiatives focusses more on rules for exchange of content. The Warwick framework explored the concept of discovery packets, as well as permission to use packets and procedures for an issuing agency. The W3 Consortium is also working on meta-data tags for Intellectual Property Rights (IPR), terms and conditions, access control, and information about people, objects (and presumably places).

Finally an eighth set of innovations is focussing on the quality rather than the quantity of the information. For instance, the introduction of digital watermarks both visible and invisible will allow libraries and museums to authenticate their images and track their usage. IBM has introduced this into the Vatican Library project. The Platform for Internet Content Selection (PICS), another W3 Consortium project, initially developed to provide a rating system for parental selection (analogous to that which the V-Chip purports to do), is being broadened to cover endorsement in general. A parallel project, in the form of Java applets will produce Digital Signatures (DSig), which will permit signed metadata and thus provide the foundations for a certificated web. In the world of traditional print we are well acquainted with rating systems ranging from the stars in a Michelin guide, a movie review or a hotel front. Tools such as the above will help us to integrate these functions into tools for the Internet.

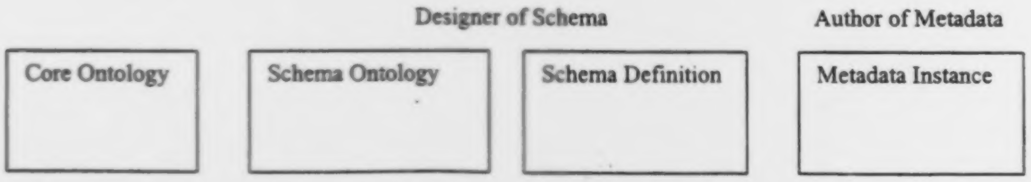
7. Implementations and Developments

Ideas are fascinating. They need to be implemented in order to change the world. Serious implementation requires a critical mass of followers such that the ideas can truly become universal standards. This is happening in the case of meta-data.[32] Support is coming from four main areas: libraries, government agencies, industry and the military. (fig. 2). The OCLC/NCSA Dublin-Warwick Framework is co-operating with the largest U.S. database in the library field, namely, the Research Library Information Network (RLIN) of the Research Library Group as well as the Library of Congress, which has been developing the Machine Readable Bibliograhic Information (MARBI), Machine Readable Card (MARC) formats and the Z.39.50 protocol. In turn, the Z.39.50 protocol has been accepted as the Gateway to European National Libraries (GABRIEL) and has the support of the International Federation of Library Associations (IFLA), which has become a reference point for many of the metadata resources.[33] At the international level also, a representative of G7 pilot project 4, Bibliotheca Universalis, has been following the meta-data developments

- A. International Standards Organization (ISO)
- B. International
    - AEGIS for G7[34]
    - Document Management Alliance[35]
    - World Wide Web (W3) Consortium
- C. National
    - ARPA Knowledge Sharing Effort (ARPA)[36]
        - Knowledge Query Manipulation Language (KQML)[37]
        - Knowledge Interchange Format (KIF)[38]
    - Biological Metadata[39]
    - Metadata Council[40]
    - Metadata Coalition[41]
    - World Wide Web (www)[42]
    - Miscellaneous (OII)
    - American National Standards Institute (ANSI)
        - X3L8[43]
        - X12
- D.
    - International Electrical Engineers (IEEE)[44]
    - Scientific Metadata
- E. Major Companies
        - Xerox Metaobject Protocols[45]

Figure 2. Some of the key players in the field of meta-data.

As for the military, in the United States, for instance, the Defense Advanced Research Projects Agency (DARPA), is extremely active in this domain. It has introduced concepts such as Knowledge Interchange Format (KIF) and Knowledge Query Markup Language (KQML) and has initiated an ARPA Research Program on National Scale Information Enterprises. In terms of industry, the efforts co-ordinated by the W3 Consortium have already been mentioned. The Open Group is also actively studying meta-data. Perhaps the most articulate public statements have come from Apple, who have published a call for a Metadata Framework.[46] Other companies such as IBM, Xerox and NEC are using metadata in their quest to establish one-stop solutions for culture and business.



Schema Ontology Syntax	Schema Definition Syntax	Metadata Instance Syntax

Fig. 3. Structure of the Multi-Schema Metadata Format by Digital Vision Laboratories.

Digital Vision Laboratories[47] is also doing very interesting work. They have created a Multi-Schema Metadata Format (MMF) and a Metadata Mediation Protocol (MMP) as the basis for an electronic commerce mediator. Their initial goal was fairly straightforward: to include characteristics of merchandise (the dress should be a given colour, size, cost), as constraints in a catalogue based retrieval system. This goal was complicated by the fact that such catalogues may use different terms to describe the same thing. The customer is searching for a dress, which may be listed under *women's garments* in one catalogue and *ladies apparel* in another. They solved this problem building on the architecture outlined in the Warwick Framework to arrive at the schema above (fig. 3).

The above is another example of how the OCLC/NCSA approach is gaining wide implementation. It confirms how business applications are profiting from experience in organization in the library world. Their pragmatic solution to a problem in everyday shopping is of further interest, because it can potentially be useful in solving two important problems in the library field. One is multiple classifications for a single term, which serves as an excellent potential tool for entering into the mind sets of different cultures. A second is the problem of related terms. A reader is searching for a book on one subject. They notice that the book also deals with other related subjects. By using these related terms the reader typically discovers valuable new materials. This process which is presently manual could be automated using the new Metadata format outlined above.

All this points to a model that goes far beyond the initial search engines. Such a model will have at least seven layers, namely, i) the user, who has access ii) to a variety of views and a iii) tools for examining iv) an object of study to which they can then apply v) basic library metadata before entering upon vi) content negotiation metadata, in order to gain access vi) to relevant contents (fig. 4).

Layer
i. User
ii. Views
iii. Tools (Editing, Searching, Browsing)
iv. Object of Study
v. Basic Library Metadata
Dublin Core Fields — Warwick Framework — Schema of Subject Headings or Classifications — Language
vi. Content Negotiation and PICS Metadata
vii. Contents

Fig. 4 A seven layered approach to meta-data.

To recognise why this is only the beginning of what is needed, a brief excursus on the structure of libraries is necessary. In the world of the great libraries the problems of meta-data are hardly new. For centuries, the great libraries had too much data to permit any one individual ever searching through every document, let alone read each one carefully. So reference rooms with at least five levels of meta-data were designed. Reference rooms contain 1) subject catalogues and classification systems, which provide the reader with a standardised set of terms, with clear indications where those terms fit in a hierarchy of ideas, i.e. references to both more universal concepts or Broader Terms (BT) and more specific or Narrower Terms (NT). Reference rooms also contain 2) dictionaries to provide readers with definitions of terms with which they are unfamiliar. They contain 3) encyclopaedias, which provide a slightly deeper insight into such unfamiliar terms and, of course, they contain 4) titles. These include a) card catalogues, b) (national) book catalogues and c) bibliographies. Book catalogues range from historical works, such as Heinsius to *Books in Print*, which are lists of titles pointing to more detailed literature (both primary and secondary) about those terms. Bibliographies are effectively a further sub-layer of meta-data insomuch as they establish links between primary works (level 6) and the secondary literature about those works (layers 7-10). Reference sections also contain 5) literature about that literature in the form of abstracts (which summarise quantity), reviews (which summarise quality) and citation indexes (which are bibliometric pointers to and, some would claim, indices of quality). The rest of the library contains 6)[48] the full contents of these books (primary literature) and 7-10) various levels of studies about these books, i.e. secondary literature (see fig. 3).

Library automation typically began by focussing on level 4) card catalogues and in some cases included samples of 6) full contents. In the past decade, work has begun on most of the other levels, namely, 1) classifications systems (e.g. Electronic Dewey); 2) dictionaries (e.g. the Oxford English and Websters); 3) encyclopaedias (e.g. the Britannica and even classics such as Thieme-Becker) and 5) citation indexes in the Humanities and Social Sciences etc. The latest advances in meta-data outlined above (fig.4) are effectively only subsets of level 4, with some references back to the subjects and classes of level 1.

A full treatment of meta-data will require a systematic correlation between all five levels of the reference sections of a library with the remaining five levels. A reader could then choose a term, see where it fit into different classifications in order to obtain a larger vocabulary, check the meanings thereof in dictionaries and/or encyclopaedias, search for titles on this topic, and then check abstracts, reviews and/or citation indexes before reading the actual books. Technologically, such a system is possible today. It will effectively bring the immense power of reference rooms in great libraries available to everyone on their desktop. Digital libraries are a wonderful idea but we need to begin with digital reference rooms. Otherwise it is like building wonderful houses without doors and windows. We need systematic entry and exit points (fig. 5).

Layer		
i.	User A	User B
ii.	User A views	User B views
iii.	User collaboration tools	
iv.	Object of Study	
v.	Library Meta-data	
	Content Pointers	(Digital Reference Room)
	1.Terms	(Subject Headings, Classifications)
	2.Terms of Definitions	(Dictionaries)
	3. Terms of Explanations	(Encyclopaedias)
	4. Terms of Titles	(Card Catalogues, National Book Catalogues, Bibliographies)
	5. Terms of Partial Contents	(Abstracts, Reviews, Citation Indexes)
vi.	Content Negotiation and PICS Meta-data	
vii.	Content Pointers	(Digital Reference Room)
	1.Terms	(Subject Headings, Classifications)
	2. Definitions	(Dictionaries)
	3. Explanations	(Encyclopaedias)
	4. Titles	(Card Catalogues, National Book Catalogues, Bibliographies)
	5. Partial Contents	(Abstracts, Reviews, Citation Indexes)
viii.	Contents	(Digital Library of Primary Literature: Facts)
	6. Full Text, Image	(Facsimiles of Original)

ix.	Contents	(Digital Library of Secondary Literature: Interpretations)
	7. Internal Analyses	(Descriptions and Studies of Contents in 6)
	8. External Analyses	(Studies of Objects, Subjects Related to 6)
	9. Restorations	(Descriptions and Methods Concerning How Objects in 6 were Restored)
	10. Reconstructions	(Models, And Other Substitutes of 6)

Fig. 5. Preliminary diagram for a bigger picture with seven layers linking user to content, integrating ten levels of knowledge as developed in the SUMS framework.

To render the resulting meta-data lists more workable, all the materials in the top five levels of knowledge would be broken down in terms of questions. Hence a person interested in biographical materials would query only those subsets pertaining to who at each of the levels, whereas a person looking for chronological information would query only subsets pertaining to when. It should be noted, moreover, that this level of queries would only be used in very complex cases.

Traditionally one only went to a major library if the material being sought was not available locally. So too will it be with online queries. Many questions are very specific and can best be answered by going to specialised databases, which have grown enormously even during the past year (1996). For example, someone wishing to find out about films would go to the Cardiff database on that subject. These will account for a majority of simple questions. More complex questions will require more complex tools accordingly. To this end each of the initiatives outlined above should be seen as complementary. In some cases, a URL, URN, URI and/or an ISBD (ER) will be sufficient. MIME types will be essential for those wishing specific kinds of media, e.g. video or databases. Site Mapping might be a default strategy for all web- sites with more than 100 pages. Similarly abstracts could be a default strategy for someone needing to master a field with hundreds of articles and books, as could the use of some kind of authentication and rating tools. Only some will need to enter into all the complexities of a major meta-data system and even this would be rendered more accessible by indications of different levels of education for which the material was written. This would permit beginners to start with introductory literature and experts to enter at the appropriate level.

Further advances will require new levels of cataloguing for existing collections. For although distinctions between primary and secondary literature are well established in theory, in practice most libraries provide no systematic links between a given primary source and the four levels of secondary literature outlined in our schema. The research of Professor Beghtol (Toronto) suggests that narrative discourse analyses can help in the refinement of classification theory. This would entail elements such as non-random characters (including narrators), events (human or non-human), settings (places, times), completion (resolution, end) and perspective (voice, point of view) in order to identify whether texts were descriptive, narrative, argumentative, literary, poetic, scientific, didactic or conversational. Such new levels of order would allow the access methods for meta-data to be refined accordingly.

In light of the above it is easy to discern why the initial search engines and browsers had such primitive results. They ignored most of the knowledge framework which libraries have laboriously developed in the course of the past three thousand years. Browsers such as Yahoo relied almost solely on personal lists of terms (a non-standardised treatment of level 1). In this context it also becomes clear why digital libraries in the fullest sense require much more than a simple scanning in of the pages. The scanned works have to be translated and new links need to be made. It may take generations to achieve this new integration of knowledge that looms as a promised land, but the sooner we begin, the sooner we shall progress towards the goal.

7. Agents and Delegation

The notion of metadata has enormous implications. It is intimately related to a whole series of new buzzwords, chief of which is agents. Some futurists such as Nicholas Negroponte and Brenda Laurel assume that agents will effectively become electronic butlers who will do our work for us. Lurking in this over optimistic techno-idealism are dangerous assumptions, or at least temptations, notably that technology can replace essential human activities

If we return for a moment to the schema in figure five, it will be seen that a (digital) library effectively has three quite separate parts namely, a reference room, a section for facts (primary literature) and a section for interpretation (secondary literature). Traditionally a great deal of time has been wasted simply sifting through the analogue versions of reference rooms in order to seek out where one might get a copy of the actual facts.[49] Agents would be ideally suited to do most of that work of finding things (which will typically range from 25-95% of a scholar's time). The user, reader, scholar decides what they want. They delegate to the machine the challenge of using digital reference rooms until they have sifted out what is being sought. Hence in terms of figure five, computers are particularly suited for helping in section one of the library.

Potentially, of course, machines can do much more than find sources. As was noted earlier they can readily handle conditions, parameters, constraints. These features are already being explored for their applicability to rating systems and they could be extended to help in the process of verifying facts, the second realm of the digital library. An obvious way is through digital signatures. A more subtle way would be in comparing texts. If it is known that a student accessed 742 texts, then machines could do a word search to see whether plagiarism was entailed. Such techniques could equally be applied to scholars, and in the analysis of texts when one is trying to assess more closely the sources of a Montaigne, an Erasmus or a Dante.

These constraint tools can also help in the realm that was central in traditional scholarship, namely interpretation. At present we have spreadsheets which translate lists into charts such that we can see new patterns in the evidence. This ability is already generating new fields such as scientific visualisation and data mining. It takes little effort to see how this could be pushed much further. New image software such as IBM's Query by Image Content (QBIC), as well as products by Illustra (now Informix) and Excalibur, are beginning to permit machine detection of colours, patterns and shapes. Given the potentials of constraint language one could therefore delegate the machine to find all paintings with a *Virgin and Child*, all paintings with a given face, or even all paintings in a given "style", assuming of course one could define it with sufficient precision. In terms of figure five, computers can thus help in the third section of libraries as well.

Object-oriented programming is leading to a whole new approach to objects.[50] In the field of Computer Aided Design (CAD), for instance, a consortium led by Autodesk is developing the principle of industry foundation classes. Hereby, a door is treated as an object (in the computer sense), such that a door for a cottage automatically adjusts to the features of a cottage door, whereas a door in a skyscraper will automatically take on the characteristics of a door in such a building. In the parlance of salesmen, the door "knows" the shape that it has to take on in different environments, i.e. it is a "smart door." In the past, one had to draw each door anew. Now one simply invokes the door (as a computer object) and it automatically becomes what it has to become (reminiscences of Aristotle's notion of entelechy).The danger with this approach is that it feeds into the McWorld syndrome to which Barber[51] drew attention, whereby every Hilton around the world looks indistinguishable, whereby a suburb of Paris is effectively indistinguishable from a suburb in Germany or the United States.

Traditionally each country and even each city had its own variations on stock objects. For a time almost every column in a mediaeval church was uniquely carved. In secular architecture, a façade in Braunschweig was slightly different from those in Wolfenbüttel nine miles away, different again from each and every city within a hundred mile radius, including Hornburg, Hildesheim, Goslar, and Quedlinburg. Each of these variants can be seen as local constraints. If each local town enters their own values within a standardised framework, then CAD objects in Hanover can automatically enter the local features to doors and other elements. In short the next stage to universal foundation classes is to add cultural dimensions which adjust geographically and temporally (i.e. historically), such that one could see, for instance, what the local Renaissance style would have been.[52]

A parallel revolution is occurring in the field of maps.[53] Tile caching methods will soon allow users to zoom seamlessly from space and link with any spot on earth. This geographical information can be linked with global positioning systems, with Computer Aided Design (CAD) programs, with Area Management/Facilities Management, with historical view to produce whole new landscapes of knowledge.[54] Some see spatial techniques as essential metaphors for conceptual navigation through visualisations of knowledge.[55]

Ultimately this theme of globalisation and uniqueness needs to be extended to the realm of languages also. The same danger of a McWorld in terms of shapes is posed by the threat that we would have a McWorld where English was the only idiom of expression. Already, there are French critics who would have us dismiss the web because there is more English than French. With the advent of Unicode and important software such as the Tango Browser by Alis Technologies, over 90 languages are covered at present. This is, however, but a small fraction of the 6,000 languages presently in use around the world. Thus, added to the challenge of getting everything on line there is the greater challenge of getting it translated into as many languages as possible. Taken seriously, this challenge will take care of much unemployment.[56]

8. Learning

In light of the above some will no doubt agree that Negroponte was surely right in his description of a world where butlers will do our scholarly work for us. Others will at least ask: is there anything left to do? On reflection the answer is definitely, yes, there will be lots left for humans to do. Computers may be useful in finding *Virgins*, even valuable in finding their lower-case variants. However, this does not address the question of what to do when one finds them. New software may provide sense-making tools, but at a certain level the challenge of how to interpret the significance of what we find will always be an essentially human task. For in this task lies the realm of meaning which is central to being human.

To see this more clearly it is useful to recognise that the ten levels of knowledge in a library are also the ten areas of learning for an individual. Potentially they are also the ten areas of their scholarly activities. Learning in its deepest sense is about all levels of knowledge and about the process of organising all those levels into understandable patterns or more precisely patterns which increase our understanding and our wisdom. Seen in this way, it soon becomes clear that most of us have a very limited sense and also limited practice of learning. The interests of most persons and the work of most scholars belong to the third section of the library. We do internal analyses. How does that motor work? We do identifications and descriptions: What is that motor part? Who is that figure? What is that object? Where is that place? Or we do external analyses: Who is that figure related to stylistically or genealogically? What are other examples of that theme? Where are other paintings by the same artist, or similar paintings? Some of us do restorations. Some historians are particularly caught up with reconstructions. Most scholarship is secondary literature, commentaries on the deeds of others.

A minority of persons actually write books which belong to the primary literature section of the library. An even smaller minority write works which affect fundamentally the reference section of the library and paradoxically this is more true the further one ascends the levels of knowledge.[57] A certain number of persons (e.g. critics) produce partial contents of books (abstracts, reviews, citation indexes). A smaller number produce titles (librarians and cataloguers) or write standard encyclopaedias. Even fewer write our standard dictionaries and even fewer still affect the great classifications such as Library of Congress. It is perhaps no coincidence therefore that we frequently remember them in terms of their author's name: Bliss, Dewey, Ranganathan. And paradoxically there is an unexpected connection with getting back to that first level of knowledge and preoccupation with the first principles of knowledge in a philosophical sense that affects the very ordering of the layers. In this realm we find the philosophers, theologians and mystics who challenge us not just in terms of this or that interpretation or definition but rather in terms of our entire framework by which we understand who, what, where, how and why we are.

At the same time, the creation of terms, naming, organising them, making classifications is perhaps the most universal of all human activities. We all make lists to make sense of the world, to impose order on it. That is what the constructivists are on about. What they overlook is that most of us are too lazy to do this for purposes other than our purely personal satisfaction and we are quite happy to accept that someone else has taken the trouble to create a more universal scheme. A few of us make an effort to go beyond the accepted schemes. We name them thinkers and intellectuals. Only the rarest succeed in creating truly useful universally applicable schemes. Somehow it is only given to these few, an Aristotle, a Plato or a Leonardo, to propose an order worth remembering, worth trying to understand, worth trying to go beyond. We call them geniuses, spiritual leaders, wise men, shamans only confirming by our poverty of words our own distance from this category making transcendence.

9. Conclusions

Computers are transforming the meaning of education in the sense that most of the traditional drudgery of learning and scholarship can soon be delegated to electronic tools in anthropomorphized forms as aids, agents, avatars or even butlers. There is not a little irony in this trend. Nearly a half century ago visionaries such as Engelbart saw in computers a new hope for unleashing individual creativity. It was a noble goal based on a tantalising premise. If only we can provide everyman with the right tools then everyman can do anything. By this premise the word processor was to make everyman an author. Millions of copies of Word Perfect and Word have been sold. A corresponding surge of Nobel laureates in literature has not been evident. Similarly, millions of Computer Aided Design (CAD) packages have been sold, but not every owner of the software has become a great designer or a famous draughtsman. Soon there will be millions of video-editing packages, but the number of memorable video and film producers will not rise proportionately. Some will be tempted to dismiss this whole exercise as a mistake or see it as confirmation that commercial interests are truly the driving force behind these developments. It may be more fruitful, however, to suggest that the experiment is unfinished because certain vital ingredients are still lacking.

Traditionally we learn best from example. There has been so much enthusiasm over the new tools that many assume or even believe that example is no longer necessary. This is reflected in catchy phrases such as: "From the sage on the stage to the guide on the side", usually pronounced by key-note speakers who are very much centre-stage. More significantly it is reflected in the politics of our educational system. For example, in faculties of education even in major universities, those who are learning to teach may find no formal courses on computers, their uses or their implications, practical, or philosophical. As a net result, we end up with magnificent tools with practically no one around who is seriously equipped to teach their uses and potentials.

Instead, teachers are provided with all kinds of theories about what computers should do for children: how they should create computer supported intentional learning environments; help them to collaborate; encourage them to create their own categories, classifications, semantic networks and world-views; give them courage to construct their own knowledge frameworks and help them to assess each others' efforts in all these endeavours.

As noted earlier these are very noble goals. They epitomise the achievements of the greatest scientists, philosophers and theologians of all time. Yet there are two fundamental differences between these great individuals of the past and our students of the present. First, these outstanding thinkers all had great teachers. Aristotle had Plato. Grosseteste, the founder of Oxford University, had Gundissalinus. Thomas Aquinas had Albertus Magnus. Yet we now expect our students to achieve great things without teachers. Indeed, we are giving them tools for manipulating words and images, tools for interpretation (part three of the library), before they have experienced the existence of solid facts (part two of the library), and without the help of all the traditional pointers to knowledge (the reference room which is part one of the library.

Second, with the great thinkers of the past there was an implicit assumption that one began by mastering the best which existed, and did not replace this until one and had achieved something which went further. Hence, in science it was useful to accept the categories of an Aristotle until a Leonardo could propose a more encompassing alternative. It was valuable to continue with the world-view of Newton until Einstein could offer a richer alternative. In the humanities generally, and in sociology and education in particular, the constraints of *more encompassing* and *richer* seem to have been forgotten. It is as if the simple act of making categories and theories, of constructivism were sufficient in itself, were virtue, as if the process were more important than the result.

If we are right, herein lie some of the deeper reasons for the discrepancies between the hype about multi-media and everyday practice; why the computer revolution, which has been imminent for so long is still only in its infant stages. We have been so busy creating the tools for the building that we temporarily forgot about the need for doors and windows. We now need to apply these tools to all parts of our libraries, which are the collective memories of all our lives. We need to bring back into focus the example of the great minds who came before. We need to show students examples. For only if we learn to see how small we are in the aeons of achievement, will we ever have the humility to unleash the incredible potentials which these past periods offer for our future insights beginning now. And only then will computers truly transform the meaning of education.

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Notes

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[1] The original title of the lecture on which this paper is based was *New Media in the Post McLuhan Age: A System for Universal Media Searching.*

[2] See, for instance, Johanna Neumann, *Lights, Camera, War. Is Media Technology Driving International Politics?*, New York: St. Martin's Press, 1996.

[3] Cf. Ralph Nader, Vandana Shiva, Martin Khor, David Morris, Herman Day, Jerry Mander et al., *The Case Against Free Trade: GATT, NAFTA and the Globalization of Corporate Power.* Earth Island Press/North Atlantic Books, 1993; John Cavanagh and Richard Barnet, *Global Dreams: Imperial Corporations and the New World Order*, New York: Simon and Schuster, 1994; David Korten, *When Corporations rule the World*, West Hartford, CT: Berrett Koehler/Kumarian Press, 1995.

[4] For an important analysis of the present trends set in an historical context see: Armand Matellart, *Mapping World Communications, Minneapolis: University of Minnesota Press, 1994. Original: La communication monde. Histoire des idées et des stratégies*, Paris: La Découverte, 1991.

[5] See http://www.infobyte.it

[6] These are: Library of Congress, Ohio Historical Society, Duke University, Harvard University, New York Public Library, North Dakota State University, Fargo; University of Chicago, University of North Carolina, University of Texas at Austin. See: http://lcweb2.loc.gov/ammem/award and http://www.ameritech.com. In addition to these there are other initiatives at Carnegie Mellon and Stanford (cf. note below).

[7] It is noteworthy that these capabilities are still absent from leading commercial products today, although a number of high-level initiatives in the fields of design, architecture and engineering are clearly moving in this direction. Autodesk for instance, has introduced the process of versioning in their AutoCAD software such that one can trace the evolution of a drawing or design and document who made what changes when. They have also introduced the notion of industry foundation classes. Hereby, a door is treated as an object (in the computer sense), such that a door for a cottage automatically adjusts to the features of a cottage door, whereas a door in a skyscraper will automatically take on the characteristics of a door in such a

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building. In the parlance of salesmen, the door "knows" the shape that it has to take on in different environments, i.e. it is a "smart door." In the past, one had to draw each door anew. Now one simply invokes the door (as a computer object) and it automatically becomes what it has to become (reminiscences of Aristotle's notion of entelechy).

[8] For more information on Engelbart's Bootstrap Institute see: http://www.bootstrap.org.

[9] Howard Rheingold, V*irtual Reality*, New York: Summit Books, 1991.

[10] Howard Rheingold, *Virtual Community*, Reading, Mass: Addison Wesley, 1993.

[11] See Pierre Levy, *L'Intelligence collective, Pour une anthropologie du cyberspace*, Paris: La Découverte, 1995.

[12] The figures used in these examples make no pretence of trying to estimate true market value. The point of the exercise is to establish the scale of the enterprise.

[13] In this context, it is useful to recall the distinction made by Professor Dertouzos between information the noun and information the verb. Information the noun is the raw material: books, manuscripts and the like. Information the verb is the realm of interpretation: what we do with this material, the activities of knowledge workers. He estimates that information the noun is 10% of the economy and information the verb is at least 60% of the economy. Owning the manuscript is simple. Scanning it in is still relatively simple. Translating it is less simple. Understanding it is anything but simple.

[14] GNU stands for GNU not Unix. The idea is to create alternative to Unix utilities. Cf.: Aeleen Frisch, *Essential System Administration*, Sebastopol: O'Reilly & Associates, 1991, xvii.

[15] See: http://www.gamelan.com

[16] See: Rex Winsbury, ed., "Digital Terrestrial TV: Descrambling the Issues," *Inter Media Special Report*, London, vol. 25, no. 2, 1997.

[17] Cf. Jeremy Rifkin, *The End of Work: The Decline of the Global Labor Force and the Dawn of the Post Market Era*, Putnam, 1995.

[18] Hans Peter Martin, Harald Schumann, *Die Globalisierungsfalle. Der Angriff auf Demokratie und Wohlstand*. Reinbek bei Hamburg: Rowohlt, 1996. Cf. Horst Afheldt, *Wohlstand Für niemand? Die marktwirtschaft entlässt ihre Kinder*, Munich: Kunstmann, 1994.

[19] Among the pioneers was the late, Yuri Rubinsky who went on to become a founder of SoftQuad, and then died tragically at an early age.

[20] Dynamic HTML will not fully solve this conflation.

[21] See http://www.infoseek.com

[22] See http://arachnid.qdeck.com/qdeck/products/webcompass/

[23] See http://www-diglib.stanford.edu

[24] Michelle Q. Wang Baldonado, "Searching, Browsing, and Metasearching with SenseMaker," *Web Techniques*, San Francisco, volume 2, issue 5, May 1997, pp. 43-47.

[25] Cf. Tom Davey, "Push meets Search," *Information Week*, Manhasset, 14 April 1997, p.72 describes three new packages Verity's Intelliserv, Excalibur's Profile and Fulchrum's Knowledge Network.'

[26] There will of course be exceptional occasions when such an exhaustive search is appropriate.

[27] See http://mcf.research.apple.com

[28] See Ramana Rao, Jan O. Pedersen, Marti A. hearst, Jock D. Mackinlay, Stuart K. Card, Larry Masinter, Per-Kristian Halvorsen, George G. Robertson, "Rich Interaction in the Digital Library," *Communications of the ACM*, New York, April 1995, vol. 38, no. 4, pp. 29-39. Cf. Stuart Card, "Visualizing Retrieved Information", *IEEE Computer Graphics and Applications*, 1996.

[29] See http://purl.org/metadata/dublin_core>

[30] See http://www.dlib.org/dlib/july96/07dempsey.html>

[31] See the article by C. Lagoze and Clifford Lynch et al. with that title at: http://cs-tr..cornell.edu:80/Dienst/Repository/2.0Body/ncstrl.cornell%2ftTR96-1593/html.

[32] As in the case of all important topics, which have become buzzwords, the term is often used very loosely with no reference to the technical meanings of the term: e.g. the Meta Lab at the University of North Carolina. Even experts admit that they are frequently uncertain of what the term means.

[33] See http://www.nlc-bnc.ca/ifla/II/metadata.htm>

[34] See http://www.ewos.be/aegis/home.htm.

[35] Organised by the Association of Information and Image Management: See http://www.aiim.org/dma.

[36] See http://www.cs.umbc.edu/agents/kse.shtml

[37] See http://cs.umbc.edu/kqml

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[38] See http://logic.stanford.edu/kif/kif.html

[39] See http://www.nbs.gov/nbii.

[40] See http://www.cutech.com/newmeta.html.

[41] See http://www.metadat.org.

[42] See http://csvu.nl/~eliens/wwww5/papers/Meta.html

[43] See http://www.lbl.gov/~olken/X3L8/activities.html

[44] See http://www.llnl.gov/liv_comp/metadata/metadata.html

[45] See http://www.parc.xerox.com/spl/projects/mops

[46] See R. V. Guha, "Meta Content Framework," *Apple Technical Report Note: 167*, Cupertino: Apple Research Laboratories, March 1997; R. V. Guha, "Meta Content Framework: A Whitepaper," *Apple Technical Report Note: 168*, Cupertino: Apple Research Laboratories, March 1997; R. V. Guha, "Towards a Theory of Meta Content," *Apple Technical Report Note: 169*, Cupertino: Apple Research Laboratories, March 1997.

[47] See Tsuyoshi Sakata, Hiroyuki Tada and Tomohisa Ohtake, "Metadata Mediation: Representation and Protocol," *The Sixth World Wide Web Conference Proceedings*, April 7-11, Santa Clara, 1997, pp. 49-59.

[48] It will be noted that these six natural components of a library comprise the first six levels of knowledge in the SUMS framework.

[49] At Wolfenbüttel, one of the greatest research libraries of the world, it was jokingly said that scholars spend 95% of their time finding a rare source and 5% of their time actually reading it. In practice the mix depends largely on the level and kind of scholarship. If one is working on a new edition of a classic text such as Hamlet and one is using the accepted sources, then search time is limited to secondary literature. If one is trying to master a field, or determine the boundaries of a new field, then it could be as high as 95%. In many cases about a third to half one's time is also spent writing the results of one's readings.

[50] For another treatment of these problems see the author's "Frontiers in Electronic Media", *ACM Interactions*, New York, July 1997, (in press).

[51] Benjamin Barber, *Jihad vs. McWorld*, New York: Random House (Time Books), 1995. Some see globalisation as necessarily wrong and the local as an alternative: e.g. Jerry Mander, Edward Goldsmith et al., eds., *The Case Against the Global Economy: And for a Turn Toward the Local*, San Francisco: Sierra Club, 1996.

[52] These problems will be explored further in the author's essay, "Global Standardisation, Regionalism, and Individual Uniqueness", *Oz. Rivista internazionale di Utopie*, Rome, vol. 4, 1997, (in press).

[53] Michael Potmesil, "Maps Alive: Viewing Geospatial Information on the WWW," *Sixth World Wide Web Conference*, Santa Clara, April 1997, TEC 153, pp. 1-13. Cf. mpm@research.bell-labs.com

[54] To give some idea of the immensity of material involved a one meter scale map of the United States requires 3,300 CD-ROMS or approximately 2,112,000 megabytes.

[55] One of the pioneers in this field is Stuart Card, as in note 28 above. Cf. *Proceedings of the Workshop on Advanced Visual Interfaces*, Gubbio, 1996. See, also the work of Heiner Benking (Ulm), who has been working on new spatial visualisations using a cognitive Panorama with a magic cube (ZauberWürfel) which serves as a "bridge between literal, figurative-metaphorical, contextual and physical landscapes of meaning, allowing us to share also information beyond meso-scale. Cf. his lecture " The Necessary next Phylogenetic Step—World View Compositions," Konrad Lorenz Institut, Altenberg/Vienna, 1997.

[56] See Terralingua at: http://cougar.ucdavis.edu/nas/terralin/home.html

[57] It is also ironic that when persons active in authoring these first five layers become too energetic they resemble secondary literature.

FLYING IN THE FACE OF INSTRUCTIONAL DESIGN (RATIONALE FOR THE CASE STUDY)

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Abstract

This paper explains the educational rationale implicit in the adoption of a case study approach to course design. 'Case study' is seen as embodying a set of educational assumptions and an appropriate learning model for applying to the problem of how professional workers learn to improve their practice by active reflection on experience. 'Case study', we claim, is not just a way of organising collections of descriptive material but implicates specific, and perhaps contentious, educational values.

Introduction

This paper gives an account of our use of CDROM(1) in a distance education program. Changing Classrooms is a year-long unit of study in Deakin's fourth year Education program in which the course team has been experimenting for ten years with ways of 'breaking the grip of print' in distance programs of this kind. This has involved increasing use of photographs, audio and video tape, which in turn has led to the development of quite different student assignments. The most recent development has been a multimedia, case study of a school. 'Hathaway Primary School' is a CDROM, which provides an extensive and diverse collection of material forming the resource basis for a six to eight week period of study (around 70 hours of student time). 'Students' (who are almost all 'teachers') are guided through this material in the expectation that it will 'take them inside' Hathaway, the fictional name given to a real school in Sydney's inner western suburbs. In this paper our concern is with the educational issues that have arisen from our attempts to become active users of CDROM technology.

Multiple technologies

Accounts of this kind are often presented within a frame that treats a single technology as an introduced variable and the course itself as a one-dimensional outcome. This frame is readily recognisable by the questions it generates:

•What did it cost? •Do the students learn better/faster as a result? •Is it more efficient? •Could we do it? •What software would we need?

The narrative structure of this 'single input/simple outcome' model is one that underlies much vernacular curriculum history and is generally of the type:

-- HISTORY (This is what we used to do)
-- INNOVATION (Here comes the innovation and isn't it great!)
-- CHANGE (This is what we are doing now)
-- EVALUATION (Is it better/cheaper/faster? Where is the resistance to change?)

Implicit in this narrative structure is the assumption of the inevitability of the flight of the arrow of progress and an unhelpful conceptual separation of technology into its material and social aspects. Tempting as it is, to tell our story in this form would be to mislead, and since Alistair Morgan (1991) has already written a history of our course which emphasises the inextricably entwined nature of its social, political and curriculum aspects with its educational technology, we cannot easily or honestly retreat from the demand for a more complex view.

What does this 'more complex view' imply?

•Rather than seeing the story in terms of the impact of a single technical innovation ('Here comes CDROM'), we prefer to see it in terms of conjunction, even a collision, between multiple technologies, each of which has material and social aspects. •The first of these lie in the nature of the innovation itself, for digital technologies are inherently complex as media. We argue that they are not just a way of adding together fragments of existing media, but in themselves constitute something new. •In addition, as Bill Green, has pointed out (personal communication), case study too is a technology, especially in the way we use it as a way of organising our teaching. For we are not simply using 'case studies' as a means of illustrating concepts we have just taught, but as a device for smuggling an ideology, a set of theories and set of practices (mostly about research, but also about teaching) into the course. The term 'case study', as we use it in our course, has a powerful hidden curriculum. •The notion of the 'course team too is a technology in the sense that course organisation, curriculum, pedagogy and assessment are mediated and managed through it -- it is the primary means by which the university gets teaching done. •The fact that the CDROM is designed for use within a distance program (though it gets many other uses), sets it in a context. This context is one in which educational technology is conventionally framed in particular ways (Evans & Nation 1989). Whatever our intentions within the course team, the university frequently presents the innovation (especially to the outside the world) as evidence to justify its image of itself as innovative within this field. (A partial fiction in which we readily collude).

What are the key educational issues?

Multimedia or multimedium?

Digital technologies are inevitably plural -- the 'Hathaway' CDROM is 'multi-media' in that it includes, video, images plus sound plus transcript, photographs, drawings, plans, 3D models and a range of formats -- academic writing, newspaper clips, observational video, tv news reports, letters, proposals, interviews, student writing, school documents, official records and forms, statistical data, street maps, architectural drawings etc etc.

We have come, though, to see this collection as constituting something beyond bricolage; for the ease of movement between forms that digitisation allows in itself creates the basis of a new medium. We tend to describe the CDROM in terms of what is familiar (as we have just done), but its novelty really lies in its functionality; it is its search capabilites, its seamlessness and its capacity for generating the unexpected that define its distinctiveness.

Distance education as technology

Distance educators approach information technologies with ambiguous feelings. On the one hand these technologies appear to promise a means of escape from the constraints which have consigned distance education to a low status position within higher education. With universal access to the internet it appears possible to break the grip of print, the boredom of the lecture hall, the tyranny of distance, the oppression of the tutorial and to replace them with (at least) a new set of cliches. On the other hand, we suspect that these promises are too readily adopted by academic administrators (who are themselves rarely educational users of the new media) and who have in mind other agenda, most of which are focussed on issues of efficiency and control. Our location within a distance education context (an institution, a curriculum, a course and a set of practices) inevitably leads us to confront the dominance, within educational technology, of the notion of 'Instructional Design'. We are well aware that 'Instructional Design' is interpreted and practiced much more loosley within our university than in many other settings (in commerce, industry and the military, for instance) but nevertheless it is there (often disguised, distorted, obscured or invisible) and needs to be addressed.

Aims, but not objectives

We have chosen not to specify learning objectives but to limit ourselves to setting educational aims. We have a diverse student group (from beginning teachers to experienced professionals, primary, secondary and adult educators from all specialisms and subject areas) and we see our educational task as encouraging them to develop their professional judgement through critical reflection. This is to invoke an educational process that is quite different from that of instructional models. It is not uniform. It builds on personal knowledge, taking bias, prejudice and self-delusion at face value. It is open-ended and context-bound. It seeks to provoke people to identify blind spots in their perceptions and so to extend their possibilites in practice (rather than to replace their routines with new behaviours).

One the claims frequently made for instructional models is that, by insisting on the behavioural expression of outcomes, they always focus directly on what is learnt rather than on what is taught. But these outcomes are almost always defined by the instructor. A key issue in professional development is to get people to identify their own learning needs, a process that it is inevitably reflective and personal. Instructional design has the effect of making the curriculum objective, removing learning from areas of personal experience and making it freely available to all who are willing to subject themselves to the process. (Its origins in military training are, as Noble (1991) has so clearly shown, deeply inscribed in its practices.) In professional education our concern is less with behavioural outcomes and more with the improvement of professional judgement.

The nature of case study

Well researched case studies intentionally provide much more information than the learner can manage or understand, most of this information is fragmentary, unsystematic, ambiguous, unreliable, perhaps redundant, irrelevant or untrue. The learning tasks to which the material is aimed are often ill-defined and so difficult to assess. All the behind-scenes work done by course developers in the instructional design model is here left for the student to do, and so she frequently finds herself unsure of the task and overwhelmed by information, most of which seems partial, confusing, poorly arranged and of doubtful reliability or validity.

This is what we like about case studies, they are like real life!

Against competency

An instructional design model may be appropriate when we are trying to teach people particular responses to relatively technical problems but it requires that we are able to squeeze what we are trying to teach into a tight frame. In fact it is surprising just what diverse fields of knowledge can be made to fit the model, as military organisations have shown, often achieving success with the very people who have been failed by schools. However, there is a cost, for in some cases it is the very judgements and conceptual imagination that is required of instructional designers that are the things we want the learner, not the teacher, to learn.

While it presents itself as rational and straightforward, for the most part instructional design does not in itself model the ways in which teachers seem to learn (even though some might say that they should). Teachers, like other professionals and jpfs (Jean Lave's neat jargon acronym for 'just plain folks'), including parents, adults attempting to program the vtr, weekend chefs and gardeners, computer programmers, dancers, jazz musicians, beginning Morris dancers and supermarket shoppers, appear to learn more from experience than from instruction. Getting things wrong is often more instructive than getting things right. Knowing you have got it wrong, with what consequences, and why, is usually memorable.

Teachers learn from the experience of teaching, of seeing others teach, from talking, reading and thinking about teaching (see, for instance Nias 1989). It follows that if we can find credible ways of simulating this experience of experience then we may be able to accelerate and extend the process of 'natural' learning, rather than imposing an over-rational, and inappropriate, frame upon it. At the heart of this effort lies a deep concern, not with competency, which is a relatively trivial educational aim, but with improving professional judgement.

Reflexivity and Writing

In devising a case we must be sure that it seems real. Credibility is an important consideration, for if the case does not seem real then it will be difficult to engage reflexivity. Reflexivity is a key to understanding how we learn from cases/experience. It implies that we learn, not just from what we see and hear or read but from reflecting on what we feel, what we think and how we change as we learn. Hence writing is an important element in learning from cases, because in writing we have to make our own sense of things: we have to engage our own subjectivity in the process(2).

Case study and distance learning

It will be clear that the notion of learning implicit in this approach is somewhat different from the theories of learning implicit in instructional design models (see also Murphy & Taylor 1993). Learning from experience is not a free gift! For we learn, not from experience itself, but from the work we put into understanding the meanings that experience has for us(3). In this we cannot put personality to one side as a set of contingent variables. In learning from experience/case studies, the person who is the learner should be at the centre of the process, not to one side of it. Not everyone will learn the same things, to the same level and in the same ways. Much of what we learn will be about how we learn, and about ourselves, and others, as learners, and it will be coded in our memories as tacit rather than propositional knowledge. When we are successful our course will provide the ground for the telling of stories, for our students will build the experience of the course into the narratives of their lives. We will do so too.

At first sight this flies in the face of the conventions of distance learning, for the term itself seems to define the teacher as a person out of consideration. The very fact that there is little room for face-to-face interaction is read by many as depersonalising the process. Our experience has been the opposite. We have come to believe that, in fact, there is a greater potential for intimacy in distance relationships than there is in the seminar room. (This should not surprise anyone who has ever read a book, watched a film, had a telephone conversation or corresponded on the internet). In all face-to-face contact, but especially in teaching, most of us self-censor and selectively project aspects of ourselves to a remarkable extent (to the point where we often no longer realise that this is what we are doing). In classrooms this is markedly so, indeed for many young teachers 'learning to teach' means extensively (and sometimes painfully) self-editing their presentation of self in order to amplify and project a very limited range of their potential selves. Perhaps paradoxically, distance programs have more scope for engaging more of the person in the process of professional development than does conventional teaching.

Assessment versus reflexivity

Assessment plays a large part in conventional instructional design. The technology of test construction is highly developed, even if in practice it is often misused. Testing is of very limited value in the face of the aims we have set for ourselves because it removes responsibility for evaluation from the student, when what is important for the learner to develop is the capacity to test their understanding for themselves. This is not easy to achieve, but in sharing what they learn, they may come to a greater understanding than they can realise alone.

In contrast with instructional design models, case studies emphasise reflexivity, they draw on and attempt to integrate with prior learning, they take a view of knowledge as subjective (and hence value-related) rather than as objective and value-free (or 'technical'). Implicit in the idea of learning from case studies is that learning is a social rather than an individual experience, that the learner is best placed to evaluate what they have learned (and has a responsibility to do so) and that this is best organised with groups or teams rather than individuals in mind.

While case studies seem to fit well with our ideas about how teachers learn, there are a number of important considerations that need to be kept in mind:

•What you learn from case studies/experience cannot be pre-specified or easily generalised. •What you learn (how much and how well) will depend mostly on the questions you bring to the case, your persistence in pursing these questions and your imaginative capacity to transform them. •Your tutor/teacher/instructor may often seem evasive when you ask just what you must do and what you should learn (eg when you ask for the objectives of the exercise). They are not being evasive, they do not and cannot know the correct answers, for there are none (though there are some that may be incorrect). •In terms of feedback you should invite, expect and welcome critique but, since there are no right answers, correction should be restricted to factual questions. The aim of the tutor should be to help you sharpen your interpretations and analyses, suggest ways you might develop them, counter assertions you might make, stretch the logic of your arguments and comment on the way you organise and present your work. •Instructional design models tend to assume that what is correct is also true and right. Case study methods thrive on drawing distinctions between these different judgements.

Case Studies: frequently raised objections

Just as instructional design models conflate learning models with approaches to teaching, assuming that a positivist, empiricist way of thinking about one also provides the best way to approach the other, so too does case study. The differences between the two are therefore in part about different views of science, different ways of looking at the world and acting within it. It follows that many of the objections that are raised to case study methods of teaching derive from objections to case study as a method of research. Thus:

Case studies are not scientific, only anecdotal

Case studies are often seen to be only stories, everyday happenings presented in everyday language. At best they are descriptive but made complicated by the idiosyncracies and variability of human social behaviour. William Ferguson (???) has described this approach to teaching as 'Aesopic' (in contrast to teaching which is 'Socratic').

Case studies are not objective

How social science comes to terms with itself as both about social action and inevitably a form of social action has been a long running debate which is far from resolved(4). In educational research this debate often sufaces in the form of a relatively superficial debate between 'quantitative' and 'qualitative' approaches to research. 'Objectivity' is sometimes claimed as a consequence of adopting accepted conventions and procedures, but to do this is to hide the issue rather than to resolve it. Objectivity, as journalists and other writers know, is the consequence of a struggle to understand, not a consequence of acquiesence to convention. Objectivity and subjectivity are therefore best thought of, not as alternatives, but as two sides of the same coin. Objectivity results, not from the denial of subjectivity, but as 'conscious control of relevant biases' (CARE undated).

You cannot generalise from a case study

It is sometimes seen to be a constraint of case studies that they are locked in the particularities of the instant and the idiosyncracies of individuals, and so unable to provide knowledge that is transferable or capable of generating theory. In the context of the problems of education, especially education within large and complex organisations, this is of course also their strength. Case studies that are more than superficial have the capacity to stall any attempts that are made to generalise or theorise from a narrow conceptual base. Case studies are best used to counter generalisations, not to illustrate, exemplify or support them. What is most powerful about case study research is that it makes generalisation from the case more difficult, not that it makes it easier.

Case studies are always about other people's problems, not mine

Where simulated experiences, such as those provided by aircraft simulators, are quickly adopted by most participants as 'real', case studies of social situations are more difficult to create. They can take you up close to others, allowing you to experience vicariously their world, putting yourself in positions where you experience dilemmas as they experience them but equally they can be used to create distance -- providing wooden descriptions of situations which we find unbelievable or in which we see all those in the case as foolish, inept or acting unethically. Creating cases is therefore something of an art, and judging quite how complicated and ambiguous to make the information we present is always a difficult decision, since it requires us to balance verisimilitude and comprehension.

Often, conveying the 'reality' of the case is less important when we are dealing with social situations, because our aim is not primarily to create a believable mock-up but to provide the basis for analysis and discussion. The Hathaway case is like this in that we are aiming to create a situation in which you feel you 'know' the school and can discuss it with some understanding of its complexity. Giving you the feeling that you are actually in a classroom or walking down a corridor is not so important as giving you the capacity to resist simple interpretations of the school. In relating to you as the user of the CDROM, our primary concern is with your thinking, rather than with providing the illusion of you being in the here-and-now of the classroom, the corridor, the playground or the staffroom.

Case studies are always conservative

Good case studies, we believe, are those which present a picture that is complex and resists simple interpretation. It follows that they also tend to resist radical analysis or prescription. The more you know and understand about a situation, institution or organisation, the more difficult it is to change it. For every change you might suggest has to be seen in a complex social context; a system within which even small changes may have complex and amplified consequences.

Summary

Implicit in what we have written is the assumption that our aim is not to achieve learning. Our aim is not that you should know 'more', but that you should improve your capacity for judgement in relation to your professional work as a teacher, ie that you should 'know better'. Learning, in this sense, is not replicable, the best we can hope for is to come to terms with the limitations of our capacity to learn from our experience.

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Notes

1.Sample pages, a description of the CDROM and a continuing discussion about uses of the material can be found at the following web page: http://www2.deakin.edu.au/sdg/hathaway/default.htm

2.Pennycook (1995), writing about comtemporary post-colonial literature, makes a strong case for the use of language (and English in particular) to 'write back', taking his cue from Salman Rushdie, who sees English as a medium in which the empire can write 'write back' to the centre.

3.We have extended this discussion in Schratz & Walker (in press)

4.An extended elaboration of this point can be found in Schratz & Walker 1995

Building Knowledge Acquisition Into The Web

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Abstract: This paper discusses the processes and problems related to designing educational content for the Web. It is suggested that the design process has to account for the types of knowledge we wish to convey in this medium, the characteristics of likely users of a coherent Web site, as well as the structures inherent to a range of different text genres, such as narrative, that might be included. In using the Web to deliver any form of content, we have to be aware of the potential as well as the limitations of this medium to provide access to an original knowledge base, for multiple users.

Introduction

In November 1995, the OLTC (Open Learning Technology Corporation) commissioned the author of this paper, to create a presence on the Web for delivery of educational content, to be published and disseminated via the EdNA (Educational Network of Australia), and administered by DEETYA (Department of Education, Employment and Training), to be on–line early April, 1996. The OLTC provided a three–four month time span for the writing of the project (December 1995–March 1996). The project, now complete, can be found at: http://www.oltc.edu.au/cp/default.html (Wild, 1996).

The scope of the completed work, entitled *Learning with software: Pedagogy and practices*, is similar to that of a traditional book. However, in most other respects, authorship in this technology is very different to the writing of a book, with the creation of this Web space encompassing fundamental issues concerned with using a new medium to represent knowledge—issues such as, creating appropriate hypermedia structures in knowledge, determining effective levels of user– or learner–control in this medium and maximising user–orientation in hyper–space.

The intention was to provide access to a expandable and dynamic knowledge base for teacher's professional development in the area of information technology pedagogy and practices. The content was not available in other forms, and necessitated delivery of different types of knowledge—experiential, empirical (research based) and theoretical. The Web was chosen as the delivery medium primarily for its ubiquity and insignificant publication costs; however, it was not chosen for its instructional effectiveness; nor was it chosen as an ideal medium for carrying a range of knowledge types. In this context, the Web was found to be restricting, despite its ever–developing capacity to carry multimedia materials and information, and its growing provision for various levels of complexity in learner–material interactions.

In using the Web to deliver any form of content, we have to be aware of the potential as well as the limitations of this medium to provide access to an original knowledge base, for multiple readers or users. Empirical and theoretical knowledge can be communicated as with the publication of traditional reference materials, with accessibility provided by keyword searches, browsing, and hierarchical and semantic linking. Much of the experiential knowledge might be represented as narrative, since this type of knowledge largely originates in story form. Yet narrative derives its usefulness as a means of communication from associative processes—how does one narrate stories about experiences so that they have meaning for all types of readers, whatever their cultural background or geographical location? More importantly, how does one represent narrative, a linear and cohesive genre, in a medium that typically encourages fragmentation and the breaking down of information into separate, discrete and disparate parts? Furthermore, an experiential knowledge base is by definition, extensible and volatile—it is apt to change, grow and be subject to redundancy: How can these processes be managed in the Web? The discussion of these and other issues and questions form the basis of this paper.

Working With The Web

The nature of the World Wide Web has attracted a great deal of rhetoric in favour of its potential to provide for a student–centred model of learning, where the learner is both intrinsically motivated and active in the learning environment (Becker & Dwyer, 1994). Indeed, at first glance there is much in the Web that appeals to educators— for example, the hypermedia information structures in the Web allow for the chunking of information, a feature that, in light of information processing theories of working memory, might be seen to support the cognitive processing of knowledge (Biggs & Moore, 1993). There have also been suggestions that in providing for browsing and thematic exploration, the Web facilitates higher order cognitive processes, such as transfer and knowledge application (Jacobson & Spiro, 1995; Oliver, Herrington, & Omari, 1996); whilst at a more conceptual level, there has always been a case made for hypertext mirroring the ways in which much of human thinking occurs—by association rather than linearly or procedurally (Burton, Moore, & Holmes, 1995; Bush, 1945; Minsky, 1975). Furthermore the Web, in terms of being a dynamic, extensive and extensible information base, provides for the ultimate in resource–rich learning.

However, we need to remember that the Web as hypermedia or hypertext, is itself only a delivery medium for information or knowledge. Hypertext does not possess a single or normative information structure—hypertext documents are created to conform or fit to a structure, imposed by their authors. At one extreme this structure might be highly ordered, supported by a constrained and sequential set of links; whilst at another extreme, the hypertext may be nonsequential and supported only by referential links. In many cases, a coherent hypertext document, such as a Web site, might comprise a mix of these structures. It is, then, the nature and application of these structures that determines the effectiveness of engagement with knowledge carried in the Web. Furthermore, to maximise engagement, the knowledge needs to conform to a structure that best fits or suits both the type of knowledge being conveyed, and the objectives set by the author for the types of interactions a user should have with it. As Jonassen points out:

> *Few designers of hypertext believe that hypertext knowledge bases should be unstructured and totally nonsequential so that users would have no guidance about the information they access. Even Nelson (1981) concedes that totally nonsequential hypertext can be disorderly and could lead to "idiosyncratic and exceptional forms of connections". Nonsequential hypertext also results in navigation problems (getting lost in hyperspace), as well as integration and synthesis problems. (Jonassen, 1990 85)*

This is the context, then, in which any Web site needs to be designed. Concern has to be taken to represent the various knowledge types in appropriate structures and to build into these structures sufficient scope for the desired learner–material interactions.

Designing For Learning

There are a range of theories available to us in designing the structures for a range of knowledge types and learner–material interactions, all based in an understanding of how people learn and each offering only a partial explanation of learning. Undoubtedly, the most prevalent set of theories in this context, in terms of their application, are cognitivist based and collectively encompass views on information processing; that is, they are largely related to views about how learners perceive, process, store and recall information. As a basis for designing learning environments, or more typically, learning activities, these theories appear adequate and well-grounded. However, they also tend to produce prescriptive and inflexible conditions or principles for learning and further, they are premised on fundamental assumptions about the nature of knowledge. Of late, these assumptions are being increasingly questioned and as a result, theories of learning and instruction that are closely referenced to these assumptions have been found wanting.

There are a number of theoretical stances that currently serve as a basis for both critiquing purely cognitivist approaches to instructional design, and for guiding the development of alternative designs. These include theories of situated cognition, cognitive apprenticeship, constructivism and the social development of knowledge. It should be made clear that such theories are not necessarily in conflict with cognitivist views of learning but that they perhaps extend or adapt cognitivist models. However, in the cases of both constructivism and conversational views of learning, there are held to be essential and fundamental differences with purely cognitive approaches. It is in constructivist and conversational theories that the design for *Learning with software: Pedagogy and practices* has its conceptual framework.

The Web In A Conversational Framework

Learning environments designed in line with a conversational framework must include discursive, adaptive, interactive and reflective components (Laurillard, 1993 100). That is, for each of these components, the learner (or reader, as we might call them in the case of a Web site) must not only have access to the major conceptions being explained or advanced but also be able to act on these explanations, to obtain feedback on their own conceptions of the same or different information, and be able to adapt the Web materials as a result of reflection. This is all completed in a framework of dialogue.

Obviously, in the case of providing information for learning on the Web, there can be no synchronous dialogue; yet there does exist the possibility for developing asynchronous dialogue—between the students and the originator of the Web materials, and also between readers. There further exists scope for adapting the information on the Web site by adding to it. Thus, in the sense of creating a conversational framework, particularly as it is interpreted and applied by Laurillard(Laurillard, 1993; Laurillard, 1995), Pask (Pask, 1976), Ramsden (Ramsden, 1992), and particularly by Vygotsky (Vygotsky, 1962), where dialogue is seen as a mediation between the known and the unknown or between the learner (reader) and the object of learning, the Web does provide a workable vehicle, especially in the application of asynchronous forums. However, it is not, perhaps, the ideal vehicle—at best it facilitates parts of the conversational framework described above, or perhaps stimulates some of the elements of instructional dialogue, even if those elements (such as the taking of action on the information) occur in the learner's (reader's) head. Moreover, the provision of intrinsic and meaningful feedback using the Web is especially problematic—in this sense the Web is not truly interactive and has no specific goal outside the goal constructions imposed by the learner.

Structures And Knowledge Acquisition

Building knowledge structures in hypertext, as with the Web, is a matter of representing interconnected segments of information, where the interconnections are usually associative and perhaps part of a complex semantic network. Essentially the links in a hypertext information base are used to imply a relationship between two or more pieces of information, as well as to make explicit a pathway between them (Horney, 1993). Yet unlike a coherent and linearly constructed argument of the type that characterises knowledge represented in a paper-based medium, the associations of information found on a Web site, no matter how complex they are, cannot by themselves represent knowledge simply by implying a relationship between two or more items of information—associating items of information does not equate to the construction of knowledge. For knowledge to be constructed, the reader has to make sense of the information association, by understanding the meaning of the association.

Thus where the Web is used to represent complex knowledge types, such as academic knowledge, it is important to make the associations or links between items or networks of information explicit. Moreover, to embed the use of the Web in a conversational framework, it is necessary to emphasise dialogue between the learner (reader) and the object of learning (the material on the Web), and to provide the facilities for this to occur.

Designing For Learning On The Web

In light of both conversation frameworks and constructivist theory, learning environments on the Web require certain pedagogical characteristics, including facilities for:

- dialogue, between:
    —learner and materials (information);
    —learner and content author (instructor);
- learners to take action on information;
- learners to negotiate task goals;
- learners to reflect and interact with descriptions of the world;
- extending or adapting the materials (information);
- providing feedback, especially intrinsic feedback, on learners' actions.

One solution to the provision of all these characteristics is in the use of forum software, software that enables asynchronous dialogue between, learner or reader and other learners; learner and information; and learner and content author. It also facilitates the taking of action on information and, if its use is structured accordingly (that is, if the task goals are described in an appropriate activity), provides a means more generally for the articulation and negotiation of knowledge. Moreover, since it promotes asynchronous dialogue, it infers that learners will be led to reflect on content before offering their own view of the world in the form of a description, or on modifying someone else's (i.e. a fellow learner's, or instructor's) descriptive view of the world. In this sense, the key to the proper use of forums lies with the setting and negotiating of task goals.

Predicting Engagement

Providing multiple access points to information on the Web and providing different ways of navigating information in this medium, is potentially an exciting way of making content material relevant and accessible to a range of readers. However, conceptually this approach presents problems. Not only is it unlikely that the designer of a Web site will be able to represent or provide scope for the navigational preferences of all readers, it is also impossible to predict how a reader will engage and interact with information represented on the Web. Indeed, there is some anecdotal evidence in the author's studies of tertiary students using the Web for learning in pre–service teacher education, that information is processed more superficially (i.e. scanning information or randomly accessing information in short snippets, with no sense of coherence or meaning for the content being engaged) than it would be if carried in a traditional medium, such as a book based in linear constructions. Indeed, this evidence is reinforced in similar observations made by others (Burbules & Callister, 1996).

As a means of professional development in teacher education (which is a focus for the Web site, *Learning with software: Pedagogy and practices)*, there might be a tendency to see the Web as a convenient, valuable and inexpensive medium. Certainly it can provide the means and resources for professionals to think about their own and others' practices, to question their own assumptions in a given domain—but it cannot presuppose that readers will actively process given information in these ways. At best, it can be hoped that readers will reflect on their own experiences or perhaps use the material presented to construct or guide their professional experiences in some way. But effective professional development, as with all learning, has to provide active means of processing and communicating experiential, empirical and theoretical knowledge—and it is unclear that the Web can comprehensively provide these means.

Narrative

Narrative is both a necessary and desirable way of representing some knowledge types, particularly experiential knowledge, which can be best provided for by using a range of conventions deriving from narrative and storytelling as text genres. Furthermore, almost all readers or Web users, can be expected to have a well–developed sense of narrative, since they will have been repeatedly exposed to this genre in both formal and informal learning environments. Indeed, the role of narrative in the representation of knowledge is central to our cognition from earliest childhood (Plowman, 1996, 96).

In this context, the Web is problematic. The key features of narrative are linearity, temporality and causality (Plowman, 1996), whilst the Web is a medium that is non–linear, non–temporal and offers no explicit representations of causality. Thus, in terms of it features as a hypermedia or hypertext information base, the Web is likely to interrupt or disrupt the construction of knowledge on the part of the learner or reader, when the reader is engaging narrative in this medium. Not only can the hyperlinks built into narrative text represented on the Web, disrupt the process of constructing meaning in the text, but also the reader's interaction with the computer (necessary in order to effect a decision or choice) is likely to interfere with the same cognitive process. Moreover, whilst the Web invites or necessitates narrative, or indeed, any text, to be broken down and represented in discrete units, this fact will undoubtedly disrupt the flow of the text in its reading, and thus interfere with the reader's attempts to make meaning.

The solution to this problem is not simplistic, but involves the design of structures which support the reader or learner in generating meaning and knowledge from narrative texts on the Web. This can be done by keeping the fracturing of narrative texts to a minimum and ensuring that operational and navigational user–computer interactions are simple. Thus, in narrative texts designers need to:

- keep hyperlinks to a minimum;
- avoid breaking texts down into discrete elements that disrupt the construction of meaning;
- employ media elements that can enhance or help represent narrative (i.e. auditory forms);
- avoid embedding interactive tasks (i.e. tasks that engage the learner in making complex decisions or navigational choices) into narrative texts.

Moreover, it is also important to consider building into narrative knowledge structures in hypertext, associations or nodes of information that are differential or, in the words of Burbules and Callister (1996), 'privileged', to avoid every association of information appearing arbitrary—so, for example, to privilege the idea of a temporal sequence or of a storyline, so as to provide the user or reader with a starting point, a centre and an exit:

> Problematizing given narratives is one thing; proposing alternative readings is another; but the very constructivist theory that encourages these also explains why a reading with no centre is no reading at all. (Burbules & Callister, 1996 33)

Conclusion

In this paper, I have raised a number of issues centred on the use of the Web as a medium for carrying various knowledge types; and particularly, issues that might mitigate against the use of the Web as a ubiquitous and generic instructional medium. Designers of Web sites need to be mindful of the limitations of this medium as a resource for learning, but also be aware of the possibilities offered in design approaches guided by conversational and constructivist frameworks. More particularly, it is important for Web designers to consider how to best represent knowledge in all its forms, especially knowledge that is derived from text genres, such as narrative, that are not readily or easily adaptable to hypermedia.

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Connecting teachers - a professional development model in a distance education context.

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Introduction

Encouraging teachers to use computer technology is a constantly renewing problem in Australia. Computer education programs which injected millions of dollars into machine placement in schools have a 15 year history (See Bigum et al 1987) which has not resulted in widespread use of computers within curriculum in Australia (Tinker et al 1995, Maslen 1995). It is often reported that teachers unwillingness to adopt technology as part of their professional and personal lives is a reason that low key, if any, computer education activity occurs in schools (Tinkler et al 1995, Spender 1996). At Queensland University of Technology (QUT), we have taken a bold stand in the midst of Government computer-injection projects, placing the 'Teachers first' philosophy at the forefront of program design. This has become increasingly brave but significant as the rush to connect schools to the Internet, has caused yet another cycle of anxieties for teachers who are trying to make sense of the myriad of ideas and pressures on them to 'do something' with the net in schools (Williams 1996 Bigum 1995). The programs discussed in this paper demonstrate clearly how important it is to connect teachers to each other, instead of believing the usual Government rhetoric which means little more than connecting school buildings. (Williams 1996)

The problem is not only that teachers are not using technologies per se. The issue is bound in the lack of opportunity for teachers to understand the technologies which they are taking into their classrooms. It is crazy to expect that teachers who do not use technology personally, have any deep understanding of their significance in the changing circumstances being created and accelerated by the global computer networks which will become increasingly prevalent. Although connection to the Internet is considered to be yet another computer initiative, it has placed attention on the age old problem of decreasing recognition of the attitudes of teachers to new technology initiatives.

Some professional development programs in computer education at QUT have been developed to help teachers understand technology differently. They have been developed in the context of changing economic and political structures in Queensland which have seen an emphasis on distance education as a delivery solution to scattered groups of teachers. This coupled with the coincidental determination to connect schools to the Internet, has created opportunities to provide some teachers with professional development programs which immerse them in the technologies they are seeking to understand from a cultural, social and economic, as well as pragmatic context.

In describing these professional development programs, this paper examines the assumptions which underpin the design of the programs. The paper points to research which has been testing the assumptions of the program creating a basis for some discussion of the design issues for computer education and computer studies professional development programs conducted for distributed teacher communities.

The programs

QUT offers two programs simultaneously for two groups of teachers. The Information Processing and Technology Professional Development Program aims to retrain teachers to teach the subject matter of the two senior secondary subjects, Information Processing and Technology (IPT), a complex theoretical subject about information and computer science and Computer Studies, a course with embedded national vocational education modules. The second program, Computers in the Curriculum (CinC), aims at providing primary and secondary teachers with knowledge and skills to make decisions about the use of computer technology in curriculum. In both these programs, teachers undertake units from a Graduate Diploma of Education (Computer Education) and participate in a professional development program. Both aspects of the programs are conducted using distance education strategies.

In the professional development component of the program, teachers are integrated into the communities of the Internet. Electronic mail becomes the management device for the program and the strategy for invoking dialogue between the teachers and between these novice teachers and their more experienced peers. Thus the program begins with intense training in connection to and use of the Internet. The teachers are encouraged to build a local support network and to identify online and local expert mentors to support them as they learn how to participate in this environment. The teachers attend local connection workshops where practical, and take part in teleconferences which build the relationships to encourage online dialogue. As the program begins, teachers are provided with paper and computer-based study materials and expected to participate in online activities around the subject matter of their coursework. The program aims to integrate the methodology of study into the lives of these teachers, rather than treat the technology as an extra thing to do.

Drawing these teachers into the computer education community in both an online and face-to-face sense is integral to changing their understanding of how this professional community sustains its professional knowledge and practice. Thus these teachers attend three and two day residential programs where experienced teachers tell them about the new ways of working and learning. The teachers also attend the computer education conferences of QSITE throughout the state and take part in the online community which sustains the organisation. The teachers are provided with one day teacher release per fortnight to visit the schools of local expert mentors, to participate in online activities and maintain their study schedule. They are encouraged to make use of the time and the program to build a way of working which will sustains them beyond the timeframe of the program.

Behind the scenes

These programs are different to traditional professional development and coursework programs that the program developers had researched or built before. With the clear determination to provide an atmosphere which would help teachers understand the technologies they were using and teaching about, the programs were centred around the development of professional communities as a place to learn and a place for teachers to engage in professional dialogue about their practice. This strategy enabled teachers to immerse in the use of technology in a way that drew attention away from the artefacts. The program developers predicted that this context for professional development might have enabled teachers to develop a more broadly based understanding of the curriculum they were teaching their own students. Thus the program design resulted from the strong rationales and assumptions from literature and experiences in distance education and professional development.

The developers of the program were influenced by the work of Lave and Wenger (1991) who identified that a community of practice within a profession, could only be achieved by active participation within the text and conversations of the community, as opposed to peripheral and passive positions. This required strategies which 'forced' teachers to participate rather than sit on the outside reading literature and thinking by themselves. This complemented the beliefs that learning is a social activity and that for teachers particularly, critical reflection through dialogue within the peer community was an appropriate forum for thinking aloud and with others. (Day 1987, Modra 1991). Electronic mail provided the means to achieve this with a geographically dispersed cohort of teachers.

Within structured activities, the teachers participated in online debates, from which they write reflections of the subject matter of the discussions and the process they undertook. Online guests, more experienced connected teachers and lecturers provided stimulus for discussion and nurtured the teachers in expressing 'ideas in progress' and refining them online in a public place. The teachers were encouraged to comment on the ideas of their peers and to question rationales and conclusions. Working with ideas and reflections of others was inherent in the academic and professional development elements of the program. Teachers could not work alone in their classrooms or studies. They could not simply articulate their own beginning opinions. They needed to map the changes in their ideas and identify what influenced the changes in their perceptions and attitudes. This same reliance on the learner community was integrated into learning how to participate in the community. The teachers were expected to learn more about the technology by asking for technical and curriculum help online and to broaden experiences by joining into other professional conversations on Australian and state Internet list communities (oz-teachers, forum and qsite-community). The technology was also the organisational conduit and communication mechanism of the program. Reading email every day became vital to participation. As one teacher said during research programs reported elsewhere in this paper, 'I did not start a new course, I found a new lifestyle'.

Distance education theory was drawn upon heavily in the design of the program. Juler's Interaction network model for distance education (1990) provided the understanding that learners in distance education programs need to build a personal network of people who support the learner during study. Thus in this program, which required that students take responsibility to overcome technical and other logistical issues, local and online helpers became an identifiable structural element, a part of the interaction network built around the program. This building process was nurtured early by teleconference ensuring the process of interaction with others became a prominent behaviour in the program. The teleconference sessions solved immediate problems and established strategies for solving further problems. Juler's model for distance education also provided the rationale for encouraging teachers to build a interaction network for their professional development, reinforcing the message that professional development was a lifelong learning activity for the teacher, a way of participating in the professional communities which surrounds computer educators. Thus Juler's model explained how important it was to integrate these teachers into their own and other communities of practice as a long term strategy. As a specific activity, teachers were asked to identify the professional online and face to face communities which would influence their understanding of the curriculum they were teaching, the technology and their way of developing professional attitudes and practices. Linking teachers to other communities online became yet another rationale for integrating these teachers into the communities of the net.

This was fortuitous because we wanted teachers to have a much deeper understanding of how professional communities worked in the circumstances of the Internet connected world and we needed teachers to understand the professional communities and directions of the information and communications technologies industries in particular. The subject matter of the new syllabuses in computer studies required teachers to understand these stories from an insider's perspective. Understanding the net was also important. We wanted teachers understand the significance of the first hand stories spun within the Internet and the stories told by other texts and media. We wanted these teachers to engage in reflections about the new space which is being dealt with in schools as just another technology, in ways that would help them help their schools make sensible curriculum, professional development and technical decisions. The programs core philosophies embedded within a distance education program provided a natural framework for immersing teachers in the culture of the online communities they needed to teach about.

Researching the programs

The distance education context of this program provided the foundation for research about the meanings of distance in a program supported by computer mediated communications. Whereas distance education environments 'emphasise the separateness of learners from teachers and from other learners' (Williams 1995a, p.24), the program was based on notions of transactional distance (Moore 1991), drawing attention to 'the separateness of learners from ideas' (Williams 1995a, p.24) as a research question. Placing learners into the new geographies of cyberspace adds a dimension to the questions of how learners understand distance.

For the participants in this study, geographic distance was read in terms of how teachers saw themselves and the problems they needed to overcome. It was the social and cultural perception of living and teaching Ôoutside of BrisbaneÕ (the capital city in the south-east corner of Queensland) that influenced attitudes to technology and their interaction with it. Comments like Ôthings are always more difficult to understand out hereÕ were used as explanations for lack of technical understanding. Teachers from more isolated geographical areas were more determined to build a strong local support network than those who lived near QUT. In contrast, Brisbane and near-Brisbane teachers struggled for a long time on their own before asking for help and then sought support from QUT staff rather than local peers. When suggestions of local onsite help were given, these participants expressed fear of Ôbothering themÕ, a common cultural attitude for urban Australians.

The research which was undertaken was important to the team who conduct the program because it drew out an insiders view of the distances participants need to meet, in order to participate actively within a professional development program constructed within online communities. In particular, one study drew attention to the social distances that were met by integrating face-to-face events with online events.

> You know this did not work as well until we had actually met each other at QUT that weekend. I think some people have been reluctant to get online and chat. I mean you

> are fairly reluctant to even pick up a telephone and ring someone you had ever met before. I donÕt send lots of messages to those I donÕt know.
>
> (Ralph, a computer studies teacher from central Queensland)

This study also drew attention to how vital it was to structure the program in a way that forced teachers to participate.

> I did not feel part of anything. I felt like I was doing a course on my own. I canÕt believe the negative feelings I had when I started. Now I am in the little groups and I have been criticising the other writing and getting help from a fellow teacher - it's like a staffroom.
>
> (Dianne, a computer studies teacher from the coastal district, just north of Brisbane)

A significant finding from further research into this program was that teachers began to reassess the significance of working within communities of teachers and others as a professional development activity. (See Williams 1995b for a discussion of the original report.) It was clearly evident that teachers attitudes to professional development changed as a result of participating within the communities model of professional development, and that they began to understand that access to communities of teachers and others was an important way for teachers to understand the curriculum they were teaching. This is exemplified in the case of one teacher who in three staged interviews moved from 'There is no new science to teach', to, 'I had no idea other teachers would help me understand the science I was teaching', to, 'I can't understand why science teachers think they can keep up to date without looking through the science discoveries reported on the net and listening to scientists talk about their work.'

These original studies led to more detailed research. The resulting review (Lloyd 1996) examined the program as an 'example of the reflective collaboration it encourages in its students. It is a familiar recursion in a course whose medium (telecommunications) is its content (computer education) and whose students are its teachers in an online community of learners' (p. 11). The program was increasingly becoming a place for teachers to experience first hand, what it is like in the communities of the Internet and this most recent study needed to explore how teachers attitudes and perceptions to the technology and technological processes changed as a result of participating in a communications technologies rich professional development environment.

In all of our studies, there is considerable evidence that connection to the Internet was a powerful influence on changing teachers understandings of the technical and non technical curriculum they taught. This most recent research provides the most useful understanding of this. In Lloyds (1996) reflection of a teacher's shift in conceptual framework, she says

> The most significant change for Dennis came in his conceptual framework. The understanding of the Internet as a link to people, not just data, is a fundamental shift, one which counters current cultural stereotypes and marketing/promotional strategies. Using the Internet to break down cultural stereotypes and using the Internet as a means of students accessing first hand stories rather than an interpretation of that information, are powerful ideas.
>
> (p. 52)

The study identified that this shift in perception came directly from how Dennis had used the Internet for his own study and professional development. This kind of evidence has been common in all studies conducted in this program. It has shown us that immersing teachers in the program as we do, engages them in the technologies in a personal way and in a way that alters their lifestyles. It is these first-hand personal experiences which in turn shape their understanding of the significance of changing technologies more generally.

Conclusion

For teachers who are involved in use of computer and communications technologies in schools in any capacity, the issue of professional development is therefore important and becoming increasingly so. Changing technologies, new curriculum directions and a shifts in the context surrounding schools mean that professional development is more of an imperative than ever before. This contrasts to continuous poor opportunities for teachers to engage with technologies in any kind of sensible way.

AT QUT, we have developed some professional development programs which immerse teachers in the technology in a personal way. A significant element of the program is that we connect these teachers to each other and other teachers via the Internet. Thus their experience of this new idea, is not that of experiencing a new technology, but as experiencing a new way of working as a professional and a new way of learning. The research projects we have undertaken have helped us understand how important this experience of the Internet and technology is, in shaping participating teachers attitudes and ideas about new technologies in education.

Note: A full version of this paper with added detail is avialable on the CD Rom of the conference. The author would prefer people to use the original paper from the CD in all academic work.

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Technology Enhanced Instruction: A Successful Model for Improving Science Teaching and Learning

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Abstract: The Technology Enhanced Secondary Science Instruction (TESSI) Project is an innovative, field-based, longitudinal study that has developed an instructional model in which computers, multimedia technology, and related resources are coupled with elements of exemplary instructional practice to enhance student learning in Science. TESSI's success in implementing effective, technology-based learning strategies is reflected in enrollment, achievement and skills-acquisition statistics. Enrollment in TESSI's Physics 12 classrooms is now more than twice the norm for British Columbia (26% versus 11%) and the failure rate on the mandatory Provincial exam is less than 1%. Enrollment of women students is approximately 40% in Physics 11 and 30% in Physics 12 - well above Provincial norms of 30% and 25%. TESSI has also successfully addressed many essential student needs - deeper learning, knowledge backed with understanding, skills in accessing and managing expanding knowledge data bases, communication skills, group problem-solving skills and self monitoring skills.

"As administrators, we have all heard about the benefits of technology. TESSI is the first program that I have seen where the benefits are actually being realized." (Cam Gesy, Principal, Brookswood Secondary School, Langley, B. C.)

Introduction:

The need for reforms in science education have been expressed by many educational theorists and science education specialists [Gess-Newsome & Lederman, 1995; Jonassen, 1994; Jonassen, Mayes, & McAleese, 1991; Yager, 1991]. For example, Linn, diSessa, Pea and Songer concluded that "*Considerable evidence from investigations in science classrooms suggests that both the science curriculum and the role of the science teacher need reformulation.*" [Linn, diSessa, Pea, & Songer, 1994, p 7] It is important that information technology play a central role in current science education reform initiatives for several reasons. The use of technology is fundamental to scientific inquiry. Scientists routinely use technology to model observations, visualize data, access and communicate information, and control experiments. Technology is expected to dramatically improve student learning and understanding [Salomon, Perkins, & Globerson, 1991]. Jonassen et al., characterize multimedia applications as potentially enhancing the learning process by fulfilling an information or knowledge construction need of the learner [Jonassen, Mayes, & McAleese, 1991]. Linn et al., visualize the use of technology to allow students to develop, test, and refine their own hypotheses regarding scientific phenomenon [Linn, diSessa, Pea, & Songer, 1994]. But, while technology affords the possibility of producing change and educational benefits, these benefits are not automatically realized because of the technology's presence [Kimmel & Deek, 1995, Stoddart & Niederhauser, 1993]. Indeed, the promises of multimedia for instruction greatly exceed the examples of effective uses of these tools. Models for the successful integration of technology with classroom practice are essential to the restructuring science education.

Purpose:

The purpose of the Technology Enhanced Secondary Science Instruction Project (TESSI) is to develop an instructional model to help teachers enhance student learning by systematically and successfully *integrating* technology into instruction. The TESSI model is founded on the premise that if Technology Enhanced Instruction (TEI) is to become an essential part of the paradigms of science classrooms, technology applications must not be supplemental to the educational process but must be *fully* integrated into courses and programs. TEI is instruction in which computers, multimedia technology, telecommunications, and related resources are used to aid student learning and access to information. TESSI implements TEI by pairing the educational opportunities provided by multimedia technologies with teaching strategies that encourage students to locate and use knowledge rather than to accept scientific information delivered through traditional, transmissive modes. Fundamental to the TESSI model is the availability of a variety of technologies within the classroom itself: technology is used as an enabling tool to enhance teaching and learning, not as a substitute for the teacher nor an "add-on" to the curriculum.

Rationale:

Fundamental to the success of implementing educational technology are the teaching strategies employed by the teachers. Rather than trying to adapt new technology into standard teaching practices, teachers must learn how to adapt their teaching strategies to accommodate the benefits made possible by technology. Using technology to simply present better classroom lectures in a teacher centered format is not the best pedagogical use of technology. The TESSI model identifies those places where the technology can increase learning effectiveness, enable learners to do what they otherwise could not, or promote the development of significant life skills. Integration, as conceived in the TESSI model, is all-inclusive, but more importantly, all-pervasive. Advantages of integration include a) an emphasis the curriculum not the computer; b) the use of multimedia applications to enhance existing objectives rather than adding new ones - i.e. it minimizes the question "how do we make room for computers?"; c) the computer becomes a partner not a competitor - vanquishes lingering fears that teachers may be displaced by computers; d) treats the computer in a natural way, as one fundamental tool for learning and living; and e) fosters the transparency of the technology.

The twenty-first century teacher must provide opportunities for students to empower themselves as self-directed learners, with the means of understanding the constantly growing database in every subject. Technology has been posited as the vehicle for accomplishing this task. Teachers are vital in this teaching-learning enterprise. They provide the essential interface among the learner, the curriculum, and the technologies; structuring, interpreting, coordinating, and integrating the educational experiences. The TESSI Project seeks to provide a model for teachers and other educators interested in undertaking the integration of technology and learning; to serve as an exemplar of how teachers and students working together, may draw upon the tools of technology, restructuring education to meet the demands of society and the diverse needs of learners.

The TESSI Model:

The design of the TESSI model was guided by three important principles:

- the selection of technology for classroom and laboratory use must be based upon a model of implementation that makes good use of available resources to enrich instruction on an on-going basis;
- the development of an effective operational model must involve practicing classroom teachers within their own classrooms, and sustained implementation over several years; and
- the participating students must perceive their use of technology as an integral part of the normal classroom procedures, rather than as an "add-on" feature, introduced by a research program.

In 1992, TESSI equipped two Physics classrooms with a multimedia center consisting of the teacher's computer and an active matrix LCD panel and high intensity overhead projector. In 1993, eight, Ethernetted, student workstations, a laserprinter, a laserdisc player, a VCR and amplifier, a TV monitor, computer simulation software, and MBL equipment were added to each classroom. For the next two years, the TESSI project director (Woodrow) met regularly with the two Physics teachers to discuss and address technological and pedagogical issues that arose as methods for integrating the various technologies were developed. A major focus of these discussions was the identification, selection and scheduling of the most valuable learning activities and resources to achieve specified curriculum objectives. The result of this research was the TESSI model - a model that integrates various teaching strategies and learning activities into a cohesive, comprehensive program that achieves desired student outcomes; a model that provides a balanced, customized program for the students and flexibility for the teacher.

The physical resources of TESSI classrooms and the TESSI pedagogical model facilitate a non-traditional model of student learning. The curriculum is presented through a combination of technology-based activities, small-group instruction, one-on-one tutorials, and hands-on activities. TESSI students are no longer passive recipients of information, but, rather, active participants in the learning process: they assume much of the responsibility for the depth and rate of their learning. Their learning is guided by a set of interactive Study Guides specifically designed for the process. Much of the work is individually directed, with students working in small groups on interactive laserdiscs and CD-ROMs, computer simulations, microcomputer-based labs (MBL), and multimedia activities, and, when necessary or desirable, with more traditional formats including texts, labs, demonstrations, problem sets, and field work. TESSI also incorporates interactive, computer-based testing to enable both the student and the teacher to quickly identify learning difficulties and plan remediation strategies. Implementing each of these technologies requires a significant departure from the traditional procedures which characterize so much of Science instruction. Each also presents challenges to the teacher to implement on an ongoing basis. Where and how should each of these technology applications be integrated into the curriculum?

In 1995-96, five more Science teachers and their classrooms were added to the Project and work began to apply the TESSI model to General Science 8-10, Chemistry 11 and 12, and Biology 11 and 12. The addition of these new subjects is enriching the model as provision is being made to accommodate varying curricular goals and subject-specific pedagogies. In Physics, for example, heavy use is made of simulations and graphing applications; in Biology, graphics and digitized video are emphasized; in Chemistry, the MBL technology is heavily used. Each technology contributes its own benefits to the instructional model; each requires its own adjustment to teaching strategies.

Methodology:

A qualitative case study methodology [Stake, 1994] supplemented by quantitative data on participation and achievement was used to assess the TESSI model. Answers were sought to one essential question: *Does technology enhanced instruction as embodied in the TESSI model improve students' learning, attitudes and skill development?* Data was gathered over a four year period beginning in 1992 using a variety of sources including: a) video-taped observations of classroom teaching and learning strategies; b) video-taped and audio-taped interviews (both formal and informal) with participating students, teachers and school administrators; c) student questionnaires eliciting attitude and cognitive information; d) longitudinal studies of course selection and success of participating students; e) journal entries by participating teachers and researchers; f) video-taped focus group discussions; and g) results on the required provincial government final exam. The long time frame of the study coupled with the consistent use of the technology by both students and teachers were deemed essential for the TESSI model's validation. The four year period, in particular, provided the opportunity to reflect upon the implementation process, test a variety of strategies, and "fine-tune" the teaching-learning process.

Outcomes:

Outcomes of the TESSI model, after five years of implementation, have been significant. The following is a sample of the project's student results in Physics:

1. increased physics enrollment. Currently, the Physics 12 participation rate at the two schools averages 26%. This figure contrasts significantly with the provincial Physics 12 participation rate norm of 11%.

2. increased physics achievement. With their high physics participation rates, both schools maintain slightly above average standings on the required, provincial Physics 12 exams and a significantly below average failure rate on this exam.

3. increased enrollment of women students. Women students presently comprise 40% of the Physics 11 enrollment at the two schools and 30% of the Physics 12 enrollment. Again, these figures are significantly above provincial norms (30% and 25%).

4. positive attitudes towards science and technology. The retention rate of students electing to continue into Physics 12 in the two schools is 80%. This rate a strong indicator of the high student interest developed by the TESSI model.

But other, more qualitative outcomes are clearly evident as well. These outcomes include: a) the development of self monitoring skills; b) improved time management skills; c) the ability to set realistic self goals; d) increased student responsibility for their learning; f) independent learning skills; g) increased problem solving skills developed through active learning, collaborative work and peer tutoring; h) enhanced technology and communication skills and preparation for post-secondary education and careers; and i) enhanced self confidence and attitudes toward learning.

TESSI students acquire these valuable learning skills by having to assume increasing responsibility for their own learning. Although most high school students (and many post secondary students) are generally not mature enough to manage completely self-paced programs, TESSI students have demonstrated the capability of managing a "controlled" self-paced program of two to three week duration wherein they manage their own time to accomplish set curriculum objectives. Within these teacher-specified time limits, students set their own pace and select activities according to their own preference and learning styles. They can work though the unit individually or collaboratively. Practice quizzes are provided for the students to check their understanding. Optional activities are available for additional practice or enrichment. Students quickly learn that by managing their time wisely they will have the opportunity to check their mastery of unit objectives and still have time to engage in extra practice when mastery is not initially attained. On-task student behavior is high in TESSI classrooms. Students remain engaged because they can progress at their own rate and because they receive immediate feedback.

To help students become self directed and self monitoring, TESSI students establish goals for each unit that are commensurate with their ability and career goals. This goal setting process has had the benefit of having the students focus on their own achievement and success. Intra-student competition is much reduced. It is a common occurrence to hear students exclaim, "I reached my goal!" upon the completion of a quiz rather than comparing absolute grades. One TESSI student reported:

> *"I like working towards my own goal. I know my friends feel the same way - I'm not compared to the brains in the class - our marks are in our folders and nobody else sees them. I know if I'm doing well or I'm behind and can choose to work to take retests if I want to. My parents like it too."* (Sara, Physics 12 student, 1995)

The TESSI model also facilitates the development of increased problem solving skills developed through active learning, collaborative work and peer tutoring, and improved independent learning skills, time management skills and self-monitoring skills. Most of the students work in pairs or triads at the computer and at their desks. For example, one group of three Physics 12 students were observed to spend 10 minutes vigorously debating whether or not mass would affect the motion of an object sliding down an inclined plane in the simulation they were studying. These students were 'thinking' and 'talking' physics!

Initially, students need guidance in adapting to this new classroom model. TESSI teachers discuss the benefits of the new learning procedures with the students and clarify the need for students to assume the responsibility for their learning. This transition process takes time and is not without problems for some students. But ultimately, students do recognize the benefits to them personally. They understand that what is being modeled is "real world learning". As one TESSI teacher explained to students

> *"We are teaching you how to learn - how to solve problems, how to manage time, how to monitor your own learning - and, - oh, by the way, - we are teaching you Physics." (A. Farenholtz, 1995)*

A special advantage of TESSI's technology enhanced model is that it permits the linking of multiple representations of knowledge. Thus, different kinds of representations - verbal, numerical, pictorial, conceptual and graphical - can all be presented to the students and interconnected. The simulations, for example, provide multiple modes of representations by linking dynamic, pictorial images of phenomena with their graphical and numerical representations, all of which are synchronized so that the simulation's effectiveness in facilitating the process of conceptual change is maximized. Indeed, the unique advantage of using computer-based simulations in science education is their ability to provide such multi-linked representations that can help students create links among different representations of a phenomenon in their own minds. Similarly, the real-time graphing techniques of the MBL probes enables the simultaneous viewing of phenomena and its graphical representation. The graphing software also facilitates the "in-depth" analysis of the collected data while the activity is in progress. The technology is used to promote student understanding of basic ideas and concepts prior to and in conjunction with the use of abstract symbols and formulas that are so characteristic of traditional science education.

The classroom ratio of students to computers of 3:1 naturally results in students working in groups with the technology. Such grouping encourages dialogue among the students. These conversations help students to link verbal representations of concepts with the pictorial representations viewed on the screen. Grouping also promotes task collaboration within the context of computer-supported learning and helps students confront and overcome preconceptions. It is not an uncommon sight to see several TESSI students at a simulation, discussing how the physical variables interact or what will happen when a variable is changed. One group was observed to "argue" for more than 10 minutes as to whether or not the mass of an object moving down an inclined plane would affect its rate of acceleration. Such student interactions are common in TESSI classrooms. Work on problem sets is also done collaboratively although students are responsible for completing their own work. The following comments, made by two of former TESSI students, - both presently pursuing post-secondary studies in science, emphasize their recognition and appreciation of skills (not content!) learned in TESSI.

> *"The things that I think I gained from being in Mr. Spann's class were working with other people, learning to solve problems together, and learning to work on your own."* (Teri, former TESSI Physics 11 and 12 student, college sophomore, February, 1995)

> *"What I valued most was] ...the group work and the independence from the teacher, having to solve the problems by ourselves, working without being told what to do."* (Jim, former TESSI Physics 11 and 12 student, college sophomore, February, 1995)

Teaching would be simpler but much less challenging if all students learned in the same manner. Technology, perhaps for the first time, provides teachers with the means to provide for the individual learning styles of their students. Some students are visual learners, others more oral; some are linear, others more global. In the TESSI model, provision for differing cognitive styles is realized in several ways. For example, wherever possible, students are given a choice of activities to meet course objectives. Labs may sometimes be completed using traditional equipment and procedures or via a simulation. Students may complete an activity using a laserdisc sequence or by a student-led analysis of a lab demonstration. Advanced problems may be completed mathematically or with the aid of a simulation to assist in the visualization of the problem context. Many times, students will complete more than one of the choices if the concept remains unclear and nearly all students at least check in on their classmates engaged in parallel activities and compare notes. The self-paced, individualized TESSI model, supported by the technology, makes it possible for the teacher to provide and manage this rich learning environment.

Conclusion:

The results of the TESSI project support claims that learning can be enhanced through the thoughtful implementation of TEI. Further, TESSI illustrates *how* technology can be successfully integrated into daily classroom practice. The TESSI model is a means whereby teachers may be guided to quickly achieve TEI learning benefits such as deeper learning, skills backed with understanding, higher scientific literacy, skills in working with knowledge, communication skills and group problem-solving skills. The TESSI model has achieved these benefits in the two Physics classrooms consistently over a five year period and is in the process of realizing the same benefits in the General Science, Chemistry and Biology classrooms. The model has been particularly successful in attracting women students to Physics and helping the "average" student to achieve success in Physics. There is every reason to believe that similar benefits will accrue from its application to other sciences. With the needs of TEI teacher training in mind, the TESSI project is currently developing a CD-ROM based, Professional Development Program based upon the results of the last four years of research. This program is expected to contribute significantly to the impact of the TESSI project. In addition, TESSI has recently been contracted by British Columbia's Ministry of Education to establish three additional TESSI development and demonstration centers in the province by providing intensive professional training for Physics teachers wishing to adopt the TESSI model. TESSI, by invitation, is also working with Mexico's Ministry of Education on a project to "modernize" Secondaria Physics instruction through the implementation of a TESSI-based approach.

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PANELS

VR: A Tool to Supplement Education

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We all know that we live in an electronic age. Everyone, it seems, is "connected", "online" and "hooked up." Many students have computers in their homes, they "surf the net", they listen to musical CD's, they play electronic games, they even "chat" with strangers via the World Wide Web (WWW). And yet, in sharp contrast to this electronic upsurge, students encounter a classroom where the most sophisticated technological tools available to them include videotapes, cable television, and overhead and slide projectors. Unfortunately, too many classrooms still utilize only a whiteboard (the upgrade to the blackboard).

In what may seem like a drastic leap from the aforementioned classroom, the Advanced Technology Center at the University of Missouri - Columbia (MU) is attempting to bridge this vast gap by assisting instructors in creating computer-generated interactive immersive environments, and making them available to students in MU's Virtual Environment Instructional Lab (VEIL). By doing so, we are discovering new methods to excite and engage students in their own learning process. Learning is being brought more in line with other aspects of students' daily lives.

One of our goals at the Advanced Technology Center is to provide faculty with the tools and technical expertise to create an educational experience that is both rewarding and effective. We look ahead and research new methods to facilitate this endeavor. Virtual Reality (VR) is one of the most effective tools that can be used to achieve this goal. We currently have nine VR projects under development, with some nearing completion.

Why VR?

VR supports the creation of sensorially rich interactive learning environments. In a virtual world, all physical barriers are removed. Obstacles which prevent classes from traveling around the world and visiting other cultures are eliminated. Students can view, and more importantly, interact with scenes from the past or the future that do not even exist. All of this can be achieved in a virtual or synthetic environment. Practically any scenario can be created or simulated in a virtual environment as long as it can be programmed. Phenomena which are either difficult to perceive or cannot be detected, such as photosynthesis, can be scientifically visualized in a virtual world in a matter of moments.

Everyone recognizes the undeniable value of books and traditional lecture materials. But many faculty at MU are eager to employ the use of VR as a supplement to enrich their conventional lessons. Concepts that may be difficult to convey in the real world can be brought to life in a virtual setting. For example, Paloma, Peru, circa 5500 BC was created in virtual reality giving students the opportunity to walk around this village and to interact with objects and the environment as it existed at that time. They came away with a greater appreciation and better understanding of this world than their peers who were taught by customary methods. There is an old saying, "Tell me and I will forget, show me and I will remember, involve me and I will understand." VR helps students understand by enabling them to experience and become engaged in the lesson.

VR Projects:

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- Virtual Environment Instructional Lab (VEIL): The University of Missouri - Columbia is the first University to have a Virtual Environment Instructional Lab with 3D stereographic HDTV, an SGI with eight R10000 processors, 3 pipe Onyx with Infinite Reality Engine and real-time digital video capabilities and a special curved screen. Students learn about such topics as Geography, Anthropology, English and Medicine in a fully immersive environment. We are also adding a six degree of freedom motion platform simulator.
- Virtual Set: The Virtual Set is a blue screen environment which utilizes digital cameras with robots, special lighting, body trackers (data suit), and a graphics-based super computer to enable live action to be embedded in virtual worlds. This technology can be used in a wide variety of applications and offers great potential for enhancing the user's virtual experience.
- A Virtual Heart with Dr. Zuhdi Lababidi: This real-time virtual reality heart beats while blood flow is animated. The model can be manipulated to allow students to explore the anatomy of the heart and also to go inside the heart and view actual heart processes such as blood flow, wall movement and valve functions. Individual heart components can be disassembled in real-time as the blood flow and heart beat continues. The next phase of this prototype will include the simulation of defective heart cases.
- Paloma World with Dr. Robert Benfer: This project is an artificial intelligence assisted virtual environment reconstruction of three ancient villages in Paloma, Peru, that were lived in from 3500 to 5500 BC and excavated by MU. The first phase of this project allows students to view realistic looking villages as presented by the instructor. The next phase, currently under construction, will incorporate QuickTime VR and a knowledge base that will be located on the Internet.
- Virtual Harlem with Bryan Carter: 1920's Harlem has been reconstructed in virtual reality for an African American Literature course at MU. Instead of just reading and analyzing literary works from this era, this prototype will allow students to become immersed and engaged in an interactive literature course.
- Intubation with Dr. Michael Prewitt: Upon completion of this project, students may learn and practice the intubation procedure in virtual reality. This will allow them to demonstrate problem solving skills for various simulated emergency conditions and patient types.
- Campus Flyover: A portion of the University of Missouri-Columbia campus has been modeled using very complex geometry from blueprints provided by MU Campus Facilities. This is the first phase of a proposed project to develop a complete VR campus to be used for promotional programs.
- Terrain Visualization with Dr. Gail Ludwig: This prototype utilizes digital terrain elevation data (DTED) to enable students to view and fly over 3D terrain maps in a virtual reality environment.
- "Making It" with Dr. Edward Brent: Virtual reality and artificial intelligence are combined to create a series of simulations designed for adolescents and young adults from ages 16 to 23. Students can experience how social constraints and their own decisions combine to affect their lives, and can even rerun the program with a different gender, race, or socioeconomic status to see the influence of those factors.

Assessment:

The usefulness and effectiveness of VR as an educational tool is only in the beginning stages of evaluation. Initially, simple surveys were developed, the results of which were extremely favorable and exceeded our expectations. We have now moved to more comprehensive assessment tools that will be used by a large number of students and will better evaluate the effectiveness of VR in the classroom. Assessment results will be tracked over the WWW and we hope to publish the results by the end of this year.

Concerns:

VR is an emerging technology that has generated not only a great deal excitement and enthusiasm, but also some worry. Some of the questions that need to be answered are: How long can a student stay in a VR environment? What is the impact of 3D stereoscopic on the user? What is the effect of the electromagnetic field generated by the body trackers? These and other questions still need to be studied and evaluated if VR is to be a viable educational tool.

INSTRUCTIONAL DESIGN FOR DISTANCE EDUCATION: HOW TO MAXIMIZE YOUR EFFECTIVENESS OVER DISTANCE

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Successful instruction over distance is far more reliant on sophisticated instructional design than on sophisticated technology. Too often we are tempted to measure the success of distance education programming in terms of having "no technical problems". But successful technology is not the goal of distance education. Positive learning outcomes is the goal, regardless of the distance and regardless of the technology.

We three authors wish to explore ways to maximize teaching effectiveness over distance by (1) reviewing the basic components of instructional design; (2) analyzing which of these components are most affected when teaching over distance; and (3) sharing some examples of how to enhance distance teaching by using the attributes of the technology(ies) being used.

What Is Instructional Design and What Does It Include?

A lesson is typically described in three major parts. The Opening introduces the presenter, participants and agenda as well as the objectives, purpose and prerequisite knowledge. The Body of the lesson encompasses the presentation and practice. Presentation is often described as "Tell-Show-Do" or information giving-modeling-checking. Practice allows students to work toward mastery of the objective under teacher supervision. The last part, Closing, lets the teacher restate the objective and students summarize what was learned.

More detailed instructional design models such as Gagne's Nine Events of Instruction (figure 1) offer additional steps. Gagne notes that the Events are not to be considered as sequential steps, but may be used in varied sequences depending on the type of lesson to be designed. Gagne's Types of Learning and the associated lesson designs offer ways to combine and recombine the Events for different learning outcomes. The lesson design changes depending on the outcome, i.e. fact lessons are designed differently than problem solving lessons and differently still from lessons for attitude outcomes.

Today's instructional designers pay increased attention to learner centered instruction which casts the instructor in the role of mentor or facilitator and the student as an active and responsible partner in the learning process. In this mode, learners need to be able to interact with each other as they become responsible for their own learning and as they negotiate the meaning of the content. Joint goal setting and evaluation, rich learning environments and cooperative interactions are keys to constructivist learning.

Which Components of Instructional Design are Most Affected When Teaching Over Distance?

Whether using video-based or computer-based, synchronous or asynchronous distance education delivery systems, the design of the lesson must be clear and systematic. Consistency facilitates learning among students who are not in physical contact with the instructor by organizing the learning within a familiar structure.

The Teletraining Institute at Oklahoma State University has defined some design components specifically for distance learning. Humanizing focuses attention on the "high touch aspects of this "high tech" interface. Making students feel comfortable, connected and motivated is essential throughout the lesson. Message Style indicates that the lesson should be well organized and in short segments, provide variety and pacing, incorporate support media such as visuals and print materials, and use activities that involve the students. Participation, whether physical or mental, should happen within the first five minutes and frequently throughout the lesson in order to increase learning. Feedback may be written or verbal and can come from ourselves or others to confirm or correct misunderstandings or omissions.

The authors have identified other factors important to consider.
Content. Not all subjects are appropriate for distance delivery. Select the best courses or parts of courses for the medium. Within the course, work at accurately assessing student entry skills and progress in learning.

Instructor. Instructor qualities are important. Not all instructors can do it well. Select them carefully. Provide incentives for instructors to teach by distance, such as released time, incentive pay, etc. Help the instructor prepare course materials and practice the equipment to the comfort level before teaching the course - anxiety transmits well.

Interactivity. Probably the most feared and hardest to master technique, it is the most important. With experience the distance becomes transparent and real intimacy can be achieved between and among groups. Instructors often feel they will not be able to pick up the nonverbal cues that indicate students are attending. Some ways to help are to have groups select a captain who speaks for them or have proctors in the room who manage the on-site activities. Use good questioning techniques all through the lesson. In ending review, have each person say what they learned. Have a Listserv where students can discuss topics with each other and with instructor.

Technologies. The change in types of media used can throw a seasoned instructor as well as students. Video is inherently a visual medium and information needs to be presented visually. Select the best medium for the content. But, some problems may be that video tapes may transmit poorly and be jerky; the chalkboard may not be very visible; transparency film is reflective - use the master copy. Voice sound is often a problem both in volume and in understandability. Also sound in the room can be disruptive - use the MUTE function. Have resources and facilities to develop multimedia materials for use in lessons. Use Internet and the Web for supplementary materials.

Room Design. Create a successful distance learning environment. Set up the room to provide areas where different types of activities can take place. Provide for instructor and student mobility. Attractive colors, room lighting, decorations are important.

Technical Issues. Make sure technical support people are available because if it can break it will. Have alternatives for when the equipment goes down.

Success Stories - Quick Tips for Teaching Over Distance

When instructors are really secure in their knowledge of content and have created a solid instructional design, they can move their teaching through time and over distance without losing any impact. In fact, when an instructor adapts the lesson to take advantage of the attributes of the technology, they may even enhance the experience.

We all know that "talking head" television was not successful because it was not supported by a strong instructional design. But as soon as we move the camera back to include additional graphics and materials, we expand our possibilities. When we take the next step and provide for total learner centered interaction, we have truly opened the door to good teaching over distance. (See figure 2)

Some of the most dynamic examples of learner centered interaction are found when the learner(s) are given control of the delivery system. Integrated voice/video/data networks such as the Kentucky TeleLinking Network (KTLN) create an environment where distant sites not only receive but also produce images. In this environment, the instructor can design activities where distant students are called on to provide segments of the lesson. For example, if several distant sites are sharing a history lesson, each site may be asked to research and then role play how a specific character from history would react to a contemporary political issue. To keep all students engaged while one site is presenting, the instructional design can include assessments and peer evaluations. Each student has a role to play, whether on camera or off. When all students are aware of their learning obligation for that lesson, they are less likely to drift away from the lesson.

Satellite (video) instruction offers less opportunity for dynamic interaction, but presents us with the extraordinary strength of broadcast quality video as a medium of instruction. Designs for satellite instruction can maximize the immediate visual opportunities and use other technologies such as audio return (phone lines) and asynchronous communication (Internet) to support learner response. The same basic concept applies here as well - each student must be aware of their learning obligations.

One of the greatest challenges facing distance educators is selecting the best medium for each component of instruction. We get trapped into thinking that satellite courses are ALL video, or that computer courses are ALL text and graphics. We must not forget that other media of instruction can allow learners to respond. FAX, mail, and telephone (including audio conferencing) are all basic, strong, versatile tools in our instructional tool box.

In addition to the mix-and-match approach to technology, we can also apply a mix-and-match approach to the "sociology" of our instructional design. Some activities are best done by individuals, some in small groups, and some with a mentor/facilitator. A good instructional design will cover or only what goes on in the classroom, but also the learning activity outside of the designated class time. Seeing the technical and the personal possibilities as a "matrix" rather than a linear progression will expand your field of vision as you develop instructional designs.

Figure 1

Gagne's Nine Events of Instruction

1. Gain Attention - Say or show something related to the lesson topic to activate alertness. Use a story or situation, dramatic picture, animation.

2. Describe the Goal - Motivate by telling what learner will be able to do after instruction, what prerequisites are necessary and why the learning is useful.

3. Recall of Prior Knowledge - Assist learners in retrieving the prerequisites via statements or pretest. Provide self-directed ways for learners to check their knowledge.

4. Present content to be learned - Show and tell the type of display to be learned from, accenting distinctive parts. Be consistent in the presentation style in order to focus attention on pertinent information rather than irrelevancies.

5. Provide guidance for learning - Help learning and retention via diagrams, pictures, lists, memory aids; organize to facilitate long term storage. Give more guidance at the beginning of the practice and build toward independent use.

6. Elicit performance - Learner demonstrates what was learned in life-like situations. Case studies and scenarios provide realistic practice opportunities.

7. Provide informative feedback - Feedback from own observation or instructor reinforces and corrects the learning.

8. Assess performance - Test learning of the material in ways similar to the practice situations.

9. Enhance retention and transfer - Review the learning and provide additional practice in various situations and spaced review of the learning to help transfer to job.

Gagne's Types of Learning Outcomes

1. Identify Facts - present and practice information.
2. Classify by Concepts - present concept and practice classifying examples.
3. Procedural Rules or Problem Solving Guidelines - provide a problem setting and practice using rules or guidelines to effectively solve the problem.
4. Motor Skills - give realistic settings for practice of a procedure.
5. Feelings / Attitudes / Values - clarify and give practice on choice making.

Figure 2

"Quick Tips" for Distance Education

1. Think of your role as a mentor / facilitator rather than a lecturer.

2. Design each lesson in segments to provide a purposeful shift in students' attention. Extended attention to either a video or computer monitor is tiring!

3. Make at least one personal visit to each distant site during the semester. Even if you are known to most of the students, your visit becomes a special event.

4. Prepare in advance so both you and your distant students have all materials in hand for the lesson. Use UPS or other ground delivery if necessary - but do not ignore other teaching materials.

5. Enjoy the new experience and down play any technical inconvenience. You are not only teaching but also modeling teaching/learning behavior.

"The Michigan Model for Educational Telecommunications: Tipping the Iceberg"

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Panel Overview

The Interactive Communications & Simulations (ICS) group at the University of Michigan's School of Education launched its first computer-mediated simulation in the Spring of 1984, and has since sponsored a number of other educational simulations which attract participants from 27 U.S. states and 23 countries. ICS's basic approach, the "iceberg metaphor," or the "Michigan model," has remained constant despite rapidly changing technology.

In this panel, Roger Espinosa will trace the historical stages of the computer interface, Jeffrey Stanzler will examine the role of university mentors in ICS exercises, and Douglass Scott will offer examples of how the iceberg metaphor shapes the role of classroom teachers.

The Iceberg Metaphor in Practice: The International Poetry Guild

ICS conceptualizes the learning experience facilitated by educational telecommunications using an iceberg metaphor. That is, the on-line communication between participants in a simulation is seen as similar to the 10% of the iceberg that remains above the water's surface. The remaining 90% of the learning experience takes place through the face-to-face interactions of students and teachers nested in classrooms around the world; interactions that are *supplemented*, rather than *supplanted*, by the on-line communications. The face-to-face component of these exercises is key to our understanding and development of computer-mediated simulations.

In practice, this model shapes ICS exercises in several ways: 1) emphasis on student-generated artifacts, 2) less directed, more open-ended student participation, 3) emphasis on student-to-student communications, and 4) scaffolding by ICS mentors for both students and teachers.

An example of this model in practice is the International Poetry Guild (IPG). Students electronically submit poems to the IPG conference where other students and ICS mentors can discuss them, offer encouragement, and make constructive comments. As poems are submitted, other participants are evaluating them for possible inclusion in their own poetry journal, a thematic collection of poems created by each class and the culminating project of each group of IPG participants. Finished journals range from the hand-made to the professional printed, but all require a great deal of time and energy to plan and execute.

IPG exemplifies ICS's emphasis on facilitating face-to-face interaction through telecommunications. Prior to submitting a poem, students would be instructed by their teacher on the genre and would practice writing different types of poetry in class. Creating a poetry journal involves editorial decisions, page layout, artwork, photography, and, in some cases, marketing as the journals are sold to generate funds to pay for the next IPG session. Thus, while IPG is facilitated by the electronic transfer of poetry and on-line discussion, the bulk of the participants' learning experience takes place through face-to-face interactions in the classroom: Interactions that would be invisible simply by reading a transcript of the on-line communications.

Making the CMC Process More Visible Through Technological Innovation

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Introduction

ICS's iceberg metaphor is about communication, and the tip of that metaphorical iceberg is computer-mediated communications. This guiding model assumes that a rich and complex set of interactions are taking place in classrooms that remain largely invisible simply by reading the on-line communications. Based on this assumption, we have attempted to create on-line environments that bring more of these interactions "to the surface." In one sense, this means providing places in the on-line environment that allow students to show some of the fruits of their face-to-face interactions. One example is putting the International Poetry Guild's participants' poetry journals on-line for all to read. Another way we work to accomplish this is to develop ways for the user to access outside resources, or for them to bring outside resources into the exercise. This capability has only become possible with the recent migration of ICS's exercises to the World Wide Web. The path we took, from CONFER II to the Web, deserves some explanation.

Past, Present, and Future Directions

ICS began on the University of Michigan's CONFER II mainframe conferencing system that offered a command-line interface. While limited, CONFER II offered item/response threading, a rare feature in even today's CMC environments. After 10 years of service, and changes both in classroom access as well as the University's computing environment, the end of the mainframe was near, and we began exploring alternative environments to support our exercises.

The first step was Visual Confer (VisCon) which had a limited ability to digest new articles. This was an advantage as it could be configured to support the goals of a particular exercises. Connectivity was another issue. Unlike CONFER, where schools could reverse phone charges, VisCon relied on schools having "Telnet" access, which proved both rare and unreliable. In addition, the digest feature didn't work well in practice and it was based on a "one computer-one classroom model" which wasn't in sync with the various end users' situations. We briefly experimented with an e-mail based digest system which offered the broadest connectivity, and provided extended support for digests which allowed it to meet our simulations' needs. However, limitations included the lack of an intuitive way to track discussion threads, as well as the difficulty of supporting the wide variety of e-mail formats used in classrooms.

We are currently experimenting with a World Wide Web/E-mail system. While this technology is relatively new, and changes rapidly, it builds upon most of the advantages of previous models, while avoiding some of their limitations (although like any new technology, it presents its own challenges). This model provides all of the advantages of the former e-mail system with three important advantages:

- outline method of seeing complete threads
- digests via the WWW (able to see the new posts since your last visit to the site)
- for e-mail users, richer posts (HTML, graphics, etc.)
- for WWW users, richer posts, links to outside resources, etc.

Mentor Issues: Examples from the International Poetry Guild

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Introduction

Much of the previous discussion of ICS's iceberg model has served to focus attention on the importance of fostering the participants' face-to-face interactions. This is an important goal, but as we shift our focus, we should not lose sight of the on-line interactions that connect the various participants. One important group in this process is the mentors, University of Michigan students specializing in a simulation's content area. In this presentation, I will focus on the role of the mentors in the International Poetry Guild (IPG), discussed above.

Mentor Challenges in the IPG

There are a number of issues that come up for the IPG mentors that center around how best to nurture creativity in others. I start with the assumption that, even if it is done under duress, it is a brave thing for a teenager to share her/his work with a worldwide audience of peers, teachers and mentors. It may also be exciting, gratifying, too abstract to get one's brain around, or even (God forbid!) a real "so what?" For argument's sake, though, let's assume that the majority of the students have some personal investment in the creation and sharing of their work, even those that would tell you they hate poetry. We should also assume that the work of these poets is frequently (and understandably) characterized by a lack of sophistication, by a heavy reliance on rhyme, and by a tendency to focus on "big" topics like love.

There are a couple of issues which I think are somewhat unique to this type of interaction. One centers around the mentors' relationships with the poets. One teacher on our network told me recently that she's often had the experience of teaching her students something about poetry and having it fall on "deaf ears." The next day, as she tells it, a communication comes from a mentor that makes the same point and, voila, it clicks! Now, what is described here is surely more complex than what this teacher relates. She is an exceptional teacher with an amazing rapport with her students and I'm sure she is underplaying her impact on her students.

This story raises an interesting issue. The mentors, in this context, have several advantages. For one, they (in contrast to the teacher) have no grading responsibility with regard to the poets. They are, however, typically far closer in age to the poets than are the teachers. They know, to paraphrase one teacher, that the Red Hot Chili Peppers are found in a music store and not a supermarket. Finally, the mentors have a clear authority in the exercise; they are the primary source of response to poems and, whether we wish it or not, judgments about them. They are also here at the University of Michigan, and this fact alone lends an authority to their words, deserved or not.

Conclusion

ICS mentors have been an indispensable part of our exercises from the beginning. My role as Staff Coordinator has brought me into contact with all our mentors for the past several years and I believe their contribution is crucial to the effective operation of our exercises. Our mentors exhibit numerous skills, content-based and interpersonal, and the role of mentoring on-line conferences is major area of research interest for me.

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Teachers' Role in the ICS Model: Examples from Middle Schools

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The Role of Teachers in the Iceberg Model

The iceberg metaphor was explained in the overview to this panel discussion and the International Poetry Guild (IPG) was offered as an example of this metaphor in practice. IPG is exemplary of how the learning of groups of students nested in classrooms is facilitated by computer links with their peers. IPG, like all other ICS exercises, progresses through student-generated artifacts (e.g. poems, messages, discussion) rather than through materials supplied by ICS. Classroom teachers are essential in guiding their students through preliminary writing exercises, helping them organize their own Guild, and supervising the creation of their poetry journal.

The notion that much (the metaphor's 10/90 split is a heuristic emphasizing the importance of in-class interactions) of the students' learning takes place within their classroom empowers teachers by acknowledging the importance of their efforts in this process. Unlike a distance learning situation where student and teacher are separated, teachers participating in ICS exercises work directly with their students and the products of these interactions are transmitted to other groups working in a similar fashion. Our simulations are predicated on this relationship as they emphasize and foster student-student and student-teacher interactions rather than asking them to rely on the exercise for exercise content.

Teachers and Technology: Scaling the Learning Curve

The push to bring schools on-line places a great burden on teachers, most of whom have little or no experience with computers or telecommunications and many struggle to include these technologies in their classes. One veteran middle school teacher with whom I spoke describes the difficulties she encounters in trying to incorporate these technologies into her teaching:

> [using computers and telecommunications] doesn't come naturally. I'm an old dog learning new tricks. But I love working with kids and I like to teach creatively and to teach relevantly and I see telecommunications as a way of communicating for the future, not just for schools, but all over the place and I feel if there's any way that I can get the kids participating in this and aware of it, that I'm doing them a service. But I have to struggle with it..."Mrs. Patterson," 7th grade science teacher

Many teachers with whom I've talked are in a similar position. They are intrigued by the potential of the Internet to bring outside resources into their classroom, but are apprehensive about how they will integrate these resources into their curriculum, and what is their role in this process.

This discussion will address my observations and experiences with classroom teachers as they work to incorporate telecommunications into their teaching. This will provide but a brief glimpse into the actual engagement of teachers and students with ICS's exercises. However, these examples serve to inform our thinking about computer-mediated communications in instructional settings, and push us to continue to develop exercises that foster our participants' face-to-face interactions.

SHORT PAPERS

AN INSTITUTION STRATEGY: DEVELOPMENTS AND EXAMPLES

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Abstract: Institute-wide strategies for development of interactive teaching materials depend on use of standards, appropriate tools and evaluation of pilot projects. HTML was selected as the foundation for all developments. Internet Explorer and Navigator are restricted as they are limited on the Windows 3.11 platform, have no integrated search capabilities and do not support linear browsing along authored routes. INK was developed to solve these problems. Here authors structure courseware in a hierarchical manner by adding HTML pages and associated index terms. INK was used to create a HTML tutor and a courseware module (Plant Sex). The tutor was successfully used to teach HTML to staff and students. Plant Sex, which includes animation (to demonstrate difficult concepts) and sound (for pronunciation of biological terms), was developed to support student groups, working in a contructivist classroom, in answering worksheets. Students enjoyed the course, found the software useful and performed better on examination.

Introduction: During the past three years the Multimedia Research Group of the University of Natal has researched the use of multimedia as a teaching aid and is involved in defining both hardware and software standards. The rapid and impressive advances in the delivery of multimedia via the World Wide Web could provide a platform for University-wide delivery of teaching materials. In this paper I will describe the strategy, illustrate the software developed to realize the strategy, and evaluate a course authored with this system.

Strategy: A number of objectives were defined and include: Adherence to international standards for delivery of teaching material; Support for Microsoft Window platforms (versions 3.11, 95 and NT); Use of a standard and easy-to-use interface; Easy maintenance of developed courseware; Delivery on both the Internet and intranets; and Rapid development and deployment of support tools (software). Hyper Text Markup Language (HTML) was selected as the standard for all interactive courseware development. To allow both hyperlinking and browsing of the material in a more linear fashion, to provide an outline of the contents and use of keyword- and free-form text searching, an authoring system was developed. Associated with a core database is the authoring system (used by faculty) and delivery system (used by students). In the following sections I will describe the tools used to create the system, the authoring and delivery programs and a HTML tutor. Thereafter I will discuss a research project that used these tools to create courseware.

Authoring System: INK, coded the Borland Delphi, consists of three work areas: toolbar, hierarchical control and HTML viewer. Commands for file manipulation (new project creation; opening of existing projects; saving of projects and publishing of documents), creation and manipulation of the project-contents (insertion and deletion of HTML files; keyword, record title and filenames editing; ordering of pages), HTML code manipulate (creation of a new page; editing of existing HTML code) and navigation tools (contents page; history; search; last page visited; previous page; next page; zoom control) are included.

Student Viewer: The viewer contains a toolbar and the HTML display object. As no menu is available, all navigation is via the mouse using the hyperlinks or the toolbar button commands (Exit, Print, Contents, History, Back, Previous Page, Next Page and Zoom). The software provides search capabilities where pages can be found using a dialog box with a hierarchical display of the contents, via authored keywords or by full-text searching.

HTML Tutor: To help University students and staff in developing courseware using HTML, an interactive tutor based on the INK system was developed. The user interface is identical to the INK viewer except that an additional component consisting of an text editor control associated with an HTML viewer control has been added to allow users to experiment interactively with HTML tags. The tutor was well received by both staff and students and demonstrated the power of the INK Development System.

Research Project: This program was initiated to: Evaluate the efficacy of a hyperlinked document as an educational support tool; Remove the artificial boundary between theoretical and practical work used in the traditional system where theory is taught in a lecture room and practical work in a laboratory; Test the delivery of teaching material developed using INK; and Illustrate alternative teaching techniques to the Department of Biology in the first instance.

Application Design: In the past a course on Fungi, Algae and Lower Plants consisted of didactic lectures and laboratory exercises. The new course was designed to place the student at the centre of the learning process and consisted of worksheets and a graphical hyperlinked document used as a support tool. The course integrated theory and practical work. Worksheets, integrating both theory and practical work, were answered by students working in groups supported by facilitators (during contact time) and the computer document available on the student Local Area Network (after contact time). The hyperlinked document, authored using INK, served as source material to the worksheets and provided definitions to all the terms used. Animation was used to explain difficult concepts, and sound for the pronunciation of biological terms. To assess student attitude, a course evaluation was conducted. To determine the effect of the change in teaching method on student performance examination results were compared to those obtained in previous years and results from the plant reproduction course compared with other modules within the course.

Research Findings: Generally students enjoyed the course but found that they needed more time to complete the tasks and would have appreciate more individual help. Students reported that the use of worksheets was appropriate, in that it allowed them to identify concepts they did not understand, encouraged active participation, enhanced understanding and made revision easier. However, they also felt that the worksheet problems were too difficult. Students found the computer programs useful and easy to use, but some would have preferred written notes. During the three years that the new course has run (1994-1996) there appears to be an increase in student performance (not statistically significant). Also, in 1996, students obtained higher marks in the constructivist course compared with other traditional instructivist courses. A change in teaching method, therefore, did not significantly alter student performance but there was an increase in the mean mark obtained.

Conclusion: An HTML-based authoring and deployment system is cheap to implement and adheres to international standards for delivery of interactive courseware. The use of Rapid Application Development tools allows for speedy implementation of the INK development and delivery systems that run on all current versions of Microsoft Windows. A modular approach used to develop the software allows for easy maintenance and extensibility. Using HTML as the base for delivery of courseware permits material to be created for both intranets and the Internet simultaneously. The use of software in a constructivist-teaching environment was successful as students appeared to enjoy the course without there being any loss in performance. This finding supports the notion that software cannot teach but can be used as an educational tool. The integration of theoretical and practical aspects of the course into one coherent whole was appreciated by most students. The INK development systems proved useful in the implementation and delivery the software. Redesign of this and other courses has stimulated discussion within the Department on alternative teaching philosophies and methods.

New Information Technologies and Rural Societies

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Abstract: Comparisons of new information technology to the telephone, the printing press and the steam engine, highlight expectations of marked changes in culture, community and society. This paper examines three rural communities in various stages of change, as it relates to Internet inception and evolution. Firstly, we investigate an Australian community that is looking to new information technology as a potential solution to their stagnating society. Secondly, we expose a Canadian locale that is dealing with the birthing pains of Internet introduction. Finally, we examine a population that has lived with the Internet successfully for three years and is moving through adolescent challenges with expectations of maturity and self-sufficiency for this new information technology.

This qualitative study will offer emergent themes that highlight potential pitfalls and provide best practice suggestions for successful introduction or harnessing of new information technologies in rural communities.

Introduction

"When historians look back at the latter half of the twentieth century it might well be remembered less as the time man walked on the moon, and more as the time we gave birth to the Internet." [1]

Presently, our own new information technology, the Internet, is undergoing an evolutionary process with the formation of its own rules, habits and resulting societal changes. This paper provides a snap shot of rural communities in two countries, traveling this evolutionary road. It is my intent that this study will provide practical assistance for Community Development Officers (CDO) in rural communities. Having worked as a CDO in rural Australia and a Consultant in rural Canada, I empathize with workers seeking rural regeneration, diversification and general community development. These emergent themes may highlight potential pitfalls and provide best practice suggestions for successful introduction or harnessing of new information technologies (NITs).

Background to the Paper

The fact that this study is still in progress dictates that this copy will be introductory only and somewhat disjointed. DAAC's Learning Systems is an independent research and training company that will provide the final report and recommendations in July; both to the Department of Family and Community Services, Australia, and the Community Economic Development Centre, Simon Fraser University, Canada. The Australian government is looking at innovative ways to assist and encourage rural community development while the Canadian organization is looking at application of NIT's to regenerate democractic, pluralistic, civil societies in the Czech Republic.

Four basic issues to be looked at are: Whether New Information Technology's (NITs) tend to segregate groups by specialized interest; whether NITs foster class/socioeconomic exclusiveness leading to issues typical of non accessibility, non-participation, and non-representation in pluralistic democratic processes; whether NITs indifference to space-important issues such as bioregional ecology frustrate community building; and , whether or not NITs make for vulnerability to subversion and top-down control.

[1] Cochran, Andrew in association with The Discovery Channel (Canada), (1996) Life on the Internet - Documentary # 1, "Understanding the Internet", Internet Site, http://cii2.cochran.com/understand/uti.html

Methodology and Research Tools

My approach to this analysis of rural communities has been decisively qualitative with questionnaires, interviews and informal discussions providing the bulk of the data. Emergent themes have been collated from transcripts. After initial contact and familiarization with the community I set up appointments for interviews and discussions and/or mingled socially with community members.

Communities and Access

Australian Community

The Australian community studied epitomizes all that is mythologised about rural Australia. In the imagination of Australians, we see the 'bush' as the backbone of our sunburnt country. This consumer image portrays "healthy produce, wholesome individuals and a pleasant relaxed lifestyle" [Stehlik 1996]. A study of the area however suggests produce that has lost its 'flavour', stubborn individuals, and a stressing lifestyle. The imagined backbone of rural Australia has developed a degenerative spinal condition. The forces that held it strong and resilient now hinder its turning and redirection. For this backbone to continue to support any activity it must flex or crumble. Diversification through empathic community development is the solution.

The farming community is reeling from the combined blow of climate and the economic demise of their primary industries. The township communities that rely on primary industry money are also feeling the pinch with fewer demands for their services and products. Civic pride is stretched as streets become patchy and services move away. [Volgyes 1980] saw a bleak future when he commented that there seems to be little practical reason for many of the country's small towns to survive. In the sixteen years since this remark, many have been amazed at the persistence of the rural sector. It is however no longer enough to merely persist, stand, and survive. In this state, a blow, such as the drought in Australia, unmasks the frailties and threatens extinction. For there to be a real future with viable options, rural communities must flex, diversify, tap into fresh sources of vitality, and find their new niche in an evolving global community.

Rural towns need to attract alternative industries or look at marketing the Australian Bush image to keep themselves viable. [Martinez-Brawley 1990] proposes a model of community development that suggests the Community Development Officer (CDO) is "an agent for change, working with the community, identifying and using the communities resources and energies for the benefit of the whole". As CDO for this district I worked with community members to devise a list of possible enterprises and options to persue. Included in this list were: tourist ventures such as a heritage centre and rural market; training options such as diversification field days and smart farming seminars; attracting new industries such as a meatworks and light manufacturing; encouraging new information technology to create new jobs and attract telecommuters. The Australian community did not have access to the Internet at the local level. Individuals had heard about the potential benefits and were looking into the necessary advances needed to entice the tele-commuter to their area.

Canadian Community Number One

The first Canadian community studied has a population of 1,500. The nearest large center (over 50,000) was 3 ½ hours by road. Forestry accounted for the majority of jobs in the area with tourism increasing steadily. A 'logging camp' mentality prevails with a feeling of impermanence still noticeable. Diversification plans have been instigated by a proactive council and their Economic Development Committee which has taken an active interest in the supply of Internet services.

The Internet Society intends to offer training and mentoring at the Learning Centre and throughout the community as well as introduce youth, community groups, entrepreneurs and local businesses to the opportunities on the Information Highway and to explore the tourism and economic development opportunities that exist with access to this information highway. The society came about when a partnership was formed with Industry Canada, educational institutions, local business and government, the library, community service groups and community media to highlight benefits of the information highway for area residents. The Internet Society now provides callers in the area with affordable access to the Internet through a high speed data transfer system located within the community. This access had been available for one month at the time of study.

Canadian Community Number Two

The second community studied has a population of 4,500. The nearest large center (over 50,000) was 1 ¼ hours by road. Forestry accounted for the majority of jobs in the area with agriculture coming in second. The community has a feel of self-reliance and pride. A resilient pioneering spirit prevails and has spilled over into innovative areas with technology embraced to reach goals.

The Access Network Organization is a community-based not-for-profit association aimed at providing a shared interactive resource through a local Internet connection. This Network provides service to a huge area that includes seven farming and forestry communities spread out over 1,500 square kilometres. More than a few public access sites were needed to effectively serve this area. The Access Network solved this problem by establishing a mobile site that travels to the ranches, community centres, and mills within the area. Training sessions are provided on request.

The local School District has established a thriving electronic busing system that has been operating since 1994. 490 students, mostly in isolated areas, receive their daily instruction through NIT's.

Conclusion

As the Internet itself continues its evolution away from its linear beginnings towards a flowing interactive and creative medium it will be able to address more easily the questions of enhancing a civil society in developed market economies. Snapshots of NIT birth and development in communities may indeed speed up this evolutionary process as we take the time to reflect and reconceive.

This study is ongoing and therefore incomplete. The penultimate report shall be presented at the conference in all its multimedia splendor with the final report available in July.

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Electronic Portfolios as a-Mechanism for Learning and Student Achievement

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Abstract

Student portfolios have been widely used for years in some areas of education.This paper discusses a technological enhancement of traditional portfolios, electronic CD-ROM portfolios. Fourteen students completed the first offering of Industrial Studies 189*: Document Production and Control Seminar* during the Spring 1996 semester. In evaluating the final electronic portfolios, the work fell into three distinct groupings. The first set maintained the paradigm of the traditional, paper-based resume and did not include many details nor multimedia features. The second group maintained the structure of the traditional resume but expanded each section including multimedia features such as videos, sounds, and/or graphics. The last group broke with the traditional paradigm and recreated new structures.

Electronic Portfolios as an Assessment Tool

According to Crouch and Fontaine [1994 p. 306], the term "portfolio is defined as a selection of assignments that a student has consciously assembled from a number of pieces produced over a semester or some other period of time." In the elementary grades, portfolios have been found to be effective in helping the teachers make instructional decisions in the classroom [Dewitz, Carr, Palm, & Spencer 1992]. A review of research in the use of portfolios in mathematics learning showed that they enhanced students' mathematics learning and communication about student progress among teachers, students, and parents [Cicmanec & Viechnicki 1994]. However, in the Vermont statewide performance assessment of portfolios, this positive impact on instruction contrasted with empirical findings about the quality and reliability of performance data the program gave [Koretz, Stecher, Klein, & McCaffrey 1994]. In the university setting, portfolios are being suggested and used as a method for assessment in teacher education because they allow both the potential teacher and the educational professor to address issues in greater depth [Richlin & Manning 1996]. In addition, they have been used in other areas including writing, education, and business communication [see Bacon & Bloom 1995; Reilly et al 1993].

Results

Fourteen students completed the first offering of Industrial Studies 189*: Document Production and Control Seminar* during the Spring 1996 semester. In evaluating the final electronic resumes, the resultant electronic resumes fell into three distinct groupings: traditional resume—4 students, extended traditional—4 students, and full multimedia—6 students.

This first group of electronic resumes maintained the paradigm of the traditional, paper-based resume and did not include many details nor multimedia features. In considering the resumes in this group, one can see that the designs are simplistic with little interaction or special effects.

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The students in this group maintained a "traditional, paper-based" paradigm despite authoring in a multimedia environment. In general, they included the exact same categories as their paper resumes and limited the information in each section to that found on a traditional resume. Although most of the students in this group fulfilled the minimum requirements for this assignment, there was little attempt to include additional features or multimedia elements into their electronic resumes.

The second group of resumes maintained the structure of the traditional resume but expanded each section including multimedia features such as videos, sounds, and/or graphics. The interface designs of this set of resumes also were simplistic with few features and details. In this way, they were similar to the resumes in group 1. This student added more multimedia features to his resume than did students in the first group.

The last group of resumes broke with the traditional paradigm and recreated new structures. When one considers the subsections of resumes in this group, they are more complex than the other two groups. Most of them include subsections (or categories) in each section. This allows the user to have more options and make more choices. Instead of having a simple screen or buttons to show each subsection, the student used pictorial or interactive approaches.

Educational Importance

The major theme throughout this paper deals with the infusion of high technology and multimedia instructional modes into the professional educational curriculum. This paper showcases one technique for promoting student learning and achievement. The development of portfolios by students is not a cursory process. In order to be effective, portfolios require students to become self-reflective and view their work as a whole rather than as unrelated pieces. Electronic resumes, as natural technological outgrowths of portfolios, can expand this active process further by encouraging students to express themselves visually as well as in written form. In addition, this study shows that the use of electronic portfolios brings learning that is interactive and socially based. Although unplanned by the instructors, students freely collaborated with each other, both in designing the multimedia as well as critiquing the content. This student-directed, collaborative learning possible is the best outcome of this activity.

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The Discourse of Online Learning: Cognitive and Interactive Dimensions

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Abstract: It is our contention that appropriately designed educational computer conferences can be an example of institutionally sanctioned space where the discourse of science represented by scholarly texts is dialogically interpreted by communities of learners [see Wertsch 1991, Wertsch and Toma 1995]. Therefore, one of the central questions facing researchers of computer conferencing proves to be: Under what circumstances do learning groups engage in a dialogue containing the cognitive patterns consistent with the instructional goals in the particular situation? How can such a dialogue be successfully nurtured? In this paper we set out to explore these questions by devising taxonomies of descriptive categories, capturing the diverse cognitive acts and interactive moves performed in the course of online group discussions. We believe that analysis of students' online discourse based on these categories can provide educators with awareness of the different choices available in designing and directing computer conferences towards their desired outcomes.

Goals of This Study

Our study focuses on computer conferences constituting a component of undergraduate and graduate level university courses in the areas of new media of communication and educational technology. The required learning activities in the courses we examined consisted mainly of critical discussion of required readings in the respective areas. The instructional goal for the online conferences was to engage students in critical thinking on problems encountered in or derived from the literature, that is, to generate personal and collective meanings on the basis of critical dialogic engagement with the content of the readings. Furthermore, thinking on these problems had to be performed collaboratively, drawing on the personal experiences and reasoning skills of all participants. Thus, critical thinking and collaboration emerged as two central concepts characterizing the normative orientation and subsequently, the goals and expectations of the instructors teaching these courses. It was implicitly assumed that critical thinking and collaboration would reinforce each other: more collaboration would bring forth a higher level of critical thinking on the part of the group as a whole.

Choosing these two concepts and the relationship between them as the centre of our interest, we sought:

(a) To devise taxonomies of descriptive categories, capturing the diverse (1) cognitive acts and (2) interactive moves performed in the course of online group discussions with a view to gaining a better understanding of the processes of critical thinking and collaboration and evaluating the conference in these terms.

(b) On the basis of these taxonomies, to identify cognitive and interactive styles exhibited by individuals and groups involved in online conferencing.

(c) To identify systematic relationships between:

- styles of group interaction and cognitive processes;
- learning activities and instructional designs on one hand, and observed cognitive activities and interactions, on the other.

Methodology

We have used as our source of data the transcripts of three online conferences carried out over one-week periods of time by student groups consisting of 5 members each, and supported by the VirtualU (a Web based educational environment developed at Simon Fraser University, Burnaby, B.C. Canada).

Qualitative and quantitative discourse analyses focusing on the functional aspect of utterances have been our main methods. Comparative analysis of the distributional structures of interactive moves and cognitive acts performed by different groups in different learning situations has been also employed.

Results

Building on previous theoretical and empirical work dealing with analysis and evaluation of educational computer conferencing [Harasim 1991], [Henri 1992], [Riel & Harasim 1994], [Newman, Webb & Cocharne 1995] and our own observations, we have created working sets of categories characterizing the two important dimensions of online discourse related respectively to critical thinking and collaboration: the cognitive and the interactive dimension. It is our premise that if we manage to describe the structure of cognitive activity performed in a conference, we will be better positioned to understand when this cognitive activity can be characterized as critical thinking. Similarly, if we manage to describe the structure of interactions observable in a conference, this would help us to judge whether and to what degree this conference has stimulated collaboration.

Each utterance pertaining to online educational discourse, we argue, is charged with either cognitive or interactive function, or both. Cognitively charged “speech acts” [Austin 1962], [Searle 1979] deal with certain operations performed on the subject matter under consideration: identifying problems, stating positions, questioning positions, etc. Interactively charged “speech acts” establish a relationship between other conference participants and the speaker: acknowledgment, support, disagreement, etc. The individual categories pertaining to each of the two dimensions have been derived from existing theoretical models [Brookfield 1987], [Garrison 1991] and empirical observations. To preserve the practical value of these taxonomies, we have tried to keep them reasonably simple and intuitive.

So far, the transcripts of four educational computer conferences (more conference transcripts to follow) have been analyzed using this approach and the developed scheme of categories. The emergent distributional structures of categorized cognitive acts and interactive moves performed by the learning groups under examination have been interpreted in light of the learning activities assigned by instructors (such as read and discuss, write a collective summary of the discussion, integrate information on the subject from external sources, etc.)

We argue that these distributional structures can be used to evaluate the group's performance and the educational success of the conference. They can be compared across conferences and related to chosen parameters of the learning situation. Also, the distributional structure of cognitive activity and interaction performed by indidvidual group members can be used to identify roles played by group members at the cognitive and the interactive plane and to evaluate their contribution to the outcomes of the collective learning experience.

Conclusion

As our project is still in its exploratory stage, we feel it would be premature to draw conclusions regarding the relationships between group interactive styles and cognitive activities. However, on the basis of the limited evidence collected so far, it can be hypothesized that groups demonstrating higher degree of interactivity (characterized by deeper involvement with other members' contributions such as support, challenge, partial disagreement, negotiation) and some degree of personal exposure (revealing personal feelings, providing personal information) tend to engage in more complex and more critical cognitive activity (characterized by analyzing problems, questioning positions expressed by others or encountered in the literature, taking new perspective to problems, etc.). We plan to explore this relationships in more depth as we gain access to more online educational conference transcripts.

We also believe that the approach we are suggesting in this paper can be brought to bear on the evaluation of online conferences for the practical purposes of instruction and technology assessment. Indisputably, the particular set of categories that is proposed here cannot be perceived as universally applicable across university disciplines and instructional goals. The idea that is generalizable across different contexts is to focus analysis and evaluation of online conferences on their cognitive and interactive dimensions developing a set of categories for each of these dimensions in accordance with the specific character of the instructional goals. Furthermore, the described analytical procedure, if found useful by instructors, could provide the basis for developing a software tool facilitating this kind of analysis.

In another vein, examining in detail what exactly students do discursively when they think critically and collaborate could provide instructors and online conference designers with helpful clues as to how to perceive and organize the online conference as a complex activity system, constituted of institutional rules and cultural norms, instructional goals, prescribed learning activities, literary sources, technological hardware and software, etc. One direction to explore is how to set the electronic "stage" so that its arrangement prompts and facilitates a particular (pedagogically desirable) kind of cognitive acts and interactive moves.

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After 400 Multimedia Projects...

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Abstract: The success of multimedia authoring projects produced by high school students is contingent on organization of the learning environment. Teachers must plan to model software, provide overviews of the project, produce template files, and supply handouts that describe all of the details to which students must attend. The storage of digital files organized into folders on cartridge drives simplifies the construction of multimedia projects. As the teacher's role shifts during this type of process-oriented work to that of a resource person, there is an inadequate of time to attend to these details once the projects begin.

Introduction

Limited access to computer facilities for an entire class is a problem requiring good organization for a unit of instruction resulting in multimedia projects [Mehan 1985]. Therefore, teachers must give adequate preparation to teaching students how to organize a project with an eye to the specific constraints impinging on the completion of work [ACOT 1991]. Throughout this paper, I am using two perspectives, the first being multimedia authoring flourishes under cooperative learning. This type of grouping fosters new understandings derived from student discussions, negotiation of meaning, reflection, and creation of mental models that emerge from conferences [Bracey 1991]. The second perspective is that authoring multimedia projects allow students to structure their ideas coherently for a large audience. With cooperative learning, a teacher moves into a new role guiding students as a resource person [Vygotsky 1978]. However, the advantages of cooperative learning, multimedia production, and this new role of teachers can only be safely attained by giving extensive care to classroom organization and management before multimedia authoring begins.

Planning Logistics for Project Completion

The complexity of managing multimedia projects requires a teacher to attend to many small organizational details in advance of launching a unit of instruction--not in the middle of it. Otherwise more and more time will be taken up with minutia rather than being spent with students trying to get them to clarify, expand, and give proof of their ideas [Cohen 1992].

Specifically, it is incumbent on an instructor to provide:

1. organization of a daily schedule for the duration of a unit.
2. directions for storage of computer files on servers or cartridge drives.
3. viewings of earlier projects pointing out the problems that each group had to overcome.
4. handouts for managing the details of scanning images, recording sound files, and assembling multimedia documents.
5. demonstrations of specific software packages via a computer projection system while students follow the teacher's mouse movements.
6. templates for projects with the buttons for navigation already in place for movement in a linear and standard hypertext fashion.
7. demonstration and use of concept mapping software for use in creating an overview of the project content and designing flowcharts of work to be accomplished by each collaborative group.
8. overviews of cooperative learning and the division of labor that typically occurs within a group.
9. time for the group to meet during class and access to computer workstations after the school day.
10. guidelines to explain how to organize sounds, graphics, video, and multimedia files in nested folders.
11. checklists for accomplishing all of the steps of a multimedia authoring project.

The Teacher as Organizer of the Instructional Environment

The use of hypermedia projects by secondary students to report research findings requires a high level of organization on the part of the teacher. High schools, no matter how well endowed with hardware in computer labs, are unable to provide sufficient resources for more than a few classes to produce lengthy multimedia projects in a concentrated period of time. Thus, out of necessity, taut organization must follow. At one level, the scheduling of rooms, due dates, and other logistics requires planning that takes place in the month before the unit of instruction begins. The date for demonstrating the projects must also be set. As a note of caution, we have found that projects require more time than teachers had originally scheduled and, thus, some of these projects become works in progress [Riel 1994].

At a higher level of complexity and detail, the teacher must always organize the means for storing projects. Currently, faculty arrange individual network accounts with passwords for each student. They key limitation of these accounts is that multimedia projects tend to run in a halting manner over a network when video and sound files are stored on a server. The most efficient means for organizing all student project resources used in multimedia production is on removable cartridges. These media must be in ample supply at the school bookstore. Removable cartridges can display multimedia files directly; archiving media such as Zip drives are not fast enough to display projects without first copying the entire document to the hard drive of a workstation.

After teachers resolve the storage issues for multimedia projects, students must learn how to organize data inside of the storage site. In short, this step means each group must learn to use nested color coded folders for holding separate scanned images, sounds, video, text, and authoring program files for efficient organization.

The Outcomes of Good Organization

As soon as these structures are in place, the collaborative groups can organize the main ideas and supporting details using well defined concept maps and begin writing these elements into a conventional research paper. The next step involves editing down this work sharply before copying and pasting the text out of a word processing file into the templates of the multimedia authoring program. If the logistical planning of the teacher has gone well, the assorted scanned images, sound files, Quicktime movies, and multimedia files lie in the designated folders of each collaborative group. Here is where the organization pays off. Students quickly assemble their multimedia document by juxtaposing the text with all of the digital files found in the resource folders. Without this planning, a class will spend endless hours in the computer center improvising solutions to problems needlessly encountered.

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Using Proximity Matrices to Identify Predominant Patterns of Navigation Through Hypermedia Knowledge Spaces

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Abstract:

In order to understand exactly how learners navigate through a given hypermedia application, it is necessary to observe their movements as they progress through and interact with it. By capturing and analyzing hypermedia navigation data, researchers and developers can gain insight into what types of learners navigate in what kinds of ways, better understand how learners go about developing knowledge in a particular domain, gather useful information for formative evaluation, accumulate data regarding the usage patterns of publicly displayed hypermedia presentations, provide learners with on-the-fly advice about how paths taken previously may bear on future choices or outcomes, determine why one path in a hypermedia application is typically chosen over another, and so on. The purpose of this article is to provide researchers and developers with a practical and effective approach to analyzing the paths learners take when progressing through a hypermedia application.

Introduction

The advent of the hypermedia application as a major means of delivering instruction in both educational and training environments has provided instructional designers with the ability to produce instructional materials that can be accessed in many different ways. This implies that two learners with the same learning objectives may navigate through the same hypermedia application in two completely different manners. This is due to the fact that learners typically bring to a given learning session different levels of interest in the topic, different world experiences, different informational needs, different levels of motivation, different problem-solving strategies, and so on, thus influencing how they navigate through the hypermedia environment [Canter, Rivers, & Storrs 1985; Jonassen 1988].

In order to understand exactly how learners navigate through a given hypermedia application, it is necessary to observe their movements as they progress through and interact with it. This is best accomplished by employing automated data collection scripts running in the background of the application itself. The benefits of using such scripts is that they can capture and store a learner's navigational choices both accurately and unobtrusively, thus improving the validity of the investigation [Qiu 1994].

Capturing and analyzing hypermedia navigation data is of interest for a number of reasons. [Beasley 1992] points out that data of this sort can be used to help us gain insight into what types of learners navigate in what kinds of ways and to better understand how learners go about developing knowledge in a particular domain. [Schwier & Misanchuk 1993] state that capturing and analyzing navigation data can provide useful information during formative evaluation, provide information for use in basic research, provide information regarding the usage patterns of publicly displayed hypermedia presentations, and provide learners with on-the-fly advice about how paths taken previously may bear on future choices or outcomes. Finally, [Orey & Nelson 1994] assert that data of this type can be used to help us understand why one path in a hypermedia application is typically chosen over another path, and how the choice of one path affects the choice of subsequent paths.

[Qiu 1994] argues that the actual paths followed by learners when navigating through a hypermedia application is a topic that has been rarely investigated and needs further study. This may be at least partly due to a lack of effective tools available that can be employ to analyze such data. The purpose of this article is to provide the researcher with both a practical and an effective approach to analyzing the paths learners take when progressing through a hypermedia application. This approach was developed for a recent investigation in which predominant patterns of navigation were identified for learners attempting to acquire knowledge from a hierarchically organized hypermedia application [Beasley & Waugh 1997]. A more complete description of this approach can be found in the CD-ROM version of this article [Beasley 1997].

Method

The method described in this article consists of six discrete steps: Data collection, data classification, proximity matrix development, navigation pattern derivation, link traversal significance determination, and visual representation.

Data Collection

For the [Beasley & Waugh 1997] study, each learner's navigation data was collected and stored in a text file by data collection scripts similar to those described in [Beasley 1992]. The data were collected in this manner because, again, they could be captured accurately and unobtrusively, thus improving the validity of the study. Upon starting the hypermedia lesson, each learner was prompted by the application to enter his or her initials and the last four digits of his or her social security number (e.g., reb5295). This participant code was used to guarantee anonymity in the study and at the same time allowed the researchers to keep each learner's data set together in a text file of that name (e.g., reb5295.txt). Each recorded entry in this file consisted of the code of the node moved to (e.g., 11, 22, 45), its title (included to aid any visual inspections of the data), and the amount of time spent on the node.

Data Classification

After the navigation data were collected and stored, the data in the Macintosh text files were converted to DOS text files and then imported into a Microsoft FoxPro 2.5b for Windows relational database table. A computer program was then developed to classify all node visits for each learner as either an initial visit or a review visit. An initial visit was defined as the first time a learner visited a given node, while a review visit was defined as any time a learner returned to a given node after visiting it initially. Classifying node visits in this manner permitted the researchers to track how the learners covered the nodes in the application the first time through it as well as how they covered them during review. It was hypothesized that these two phases of the learner's study session would produce markedly different patterns of navigation and should thus be segregated.

Proximity Matrix Development

Once all learner navigation data were imported into the relational database table, two proximity matrices were developed--one for the initial phase of the learners' study sessions and one for the review phase. Since there were 40 nodes in the lesson, each proximity matrix consisted of 40 columns and 40 rows. Each column-row intersection represented a potential link from one node to another. Thus, there were m(m - 1), or 40(39) = 1560, potential links between the nodes in the application, where m = 40 nodes. A computer program was then developed which incremented the corresponding row-column intersection by one, each time a given node-to-node link was traversed. After all navigation data were analyzed, the frequencies of individual link traversals were available in the two proximity matrices.

Navigation Pattern Derivation

After the proximity matrices were developed, predominant patterns of navigation through the hypermedia application were derived. This task was accomplished by systematically comparing the moves emanating from each node in the system. In the [Beasley & Waugh 1997] study, for example, there were four nodes (i.e., node 21, node 22, node 23, and node 24) to which a learner could move from node 11. A computer program was developed that determined which of the four possible links (i.e., node 11 to node 21, node 11 to node 22, node 11 to node 23, or node 11 to node 24) was traversed most frequently. After determining the most frequently taken link from node 11, the program moved across that link and began the process again until all the links were analyzed or the path in the proximity matrix was terminated. The algorithm used in this analysis does not allow a return visit to a node that has already been analyzed.

Link Traversal Significance Determination

Once predominant patterns of navigation were derived, each node-to-node link traversal was analyzed to determine if the proportion of traversals across that link was significantly larger than any non-predominant link traversals emanating from the same node. To do this, the proportion of each link traversal emanating from a given node was determined by dividing the number of traversals moving away from the current node by the number of visits to the current node. For example, the learners using the system moved from node 3f to node 24 thirty-three times and node 3f was visited a total of fifty-nine times. Thus, the proportion of moves from node 3f to 24 was 33/59 or 56 percent. Notice that this technique addresses the problem of what value to use in the denominator of such a proportion [Schwier & Misanchuk 1990]. Next, the statistical significance of this proportion was tested. A z-test was used to test the equality of two proportions, and that the proportions compared were those of the most frequently traversed link from a given node and those of the second most frequently traversed link from that same node.

Visual Representation

After each predominant node-to-node link traversal was analyzed to determine its statistical significance, a visual representation of these links was created. This was done to give the researchers a clearer understanding of the predominant patterns of navigation taken through the hypermedia application.

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Base Models for Organizing the Logical-Operatory Analysis of Cooperative Computational Environments

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Abstract

In this work we report, from a piagetian logical-operatory point of view, some important concepts for the operatory analysis of the interaction processes between subjects and cooperative computational environments. We introduce construct three models which involve aspects of the user and/or programmer subject representation activity (like the mental image of the interaction process), as well as the relationships that can be realized among the subjects and the computational environment. We sketch in a preliminary way the intended use of the models.

Keywords: Computer Supported Cooperative Work (CSCW), Cooperative Environments, Operatory Analysis, Collective Representation.

The aim of this study is to investigate, from a piagetian operatory-logic point of view, different computational environments that allow the construction of a "*collective knowledge*". For that, it is necessary to understand some basic concepts of this theory which explain the subject's representative activity in an individual and collective level as well as the different elements that, in our interpretation, are involved in the cooperative interaction between subjects and the computational environments (elements like: the mental image of the interaction process, their computational representation in a individual/collective plan, etc). We use these concepts to construct and study some models of interaction processes in order to characterize the operations that are performed both by the programs and the subjects which are working together in a group.

To understand, from a logical operatory viewpoint, the interactions between the subjects and the cooperative computational environment, it is necessary not only to model the subjects cognitive and action structures in terms of operation structures, but also to model the computational cooperative environment in the same terms. Piaget's operatory logic was developed to model cognitive and action structures of subjects in problem-solving situations. But, to our knowledge, no suitable account has been given, in logical-operatory terms, of the behavior of computational environments.

Without such an account, modeling the interaction process between subjects and computational environments requires dealing with two fundamentally different languages: the logical-operatory language of Piaget's psychology and epistemology, and the language of theoretical computer science, where the semantics of computer systems are analyzed and explained. This language is very close to that of the so-called information processing psychology, which on its turn is quite distant from the language of Piaget's theory.

To fill the gap between those two different viewpoints, we propose to develop models of computer systems using the language of Piaget's operatory logic. This should be directly relevant to the piagetian study of human behavior in cooperative computational environments, since they should allow the description of user-computer interactions in the same logical-operatory language.

We've started the development of such models by analyzing in logical-operatory terms simple computer applications frequently used in educational environments, such as the graphical editor Paintbrush for Windows, the WinLogo programming environment, and the text editor Word 6.0, among others.

In such preliminary studies we explained in logical and infralogical terms both the behavior of subjects and computational environments, as well as their interactions. Such studies concerned non-cooperative situations, involving a single user and a single computer, and although they are the basis for the study of cooperative environments that we are starting to report here, they can not be directly applied to such cooperative environments, because of the additional involvement brought in by the presence of the interaction processes among the diverse subjects in such environments.

To organize the extension of our previous results concerning non-cooperative environments to the cooperative ones we intend to study some base models are necessary, which should be used to organize the logical-operatory analysis, allowing the definition of concepts such as organizational roles, organizational structures, and organizational processes [Costa 95], in which the piagetian logical-operatory concepts we used before can acquire the multi-subject dimensions needed for our current task. This study introduces three such base models, making explicit roles, structures and processes present in the use of cooperative computational environments, so that the definition of the logical-operatory structures needed for the analysis of such use can now proceed adequately.

The first type of interaction model is the simplest one. It concerns a centralized tool that is used in a cooperative form by several users. In this model, the users do their collective representation of the mental image through the language supported by the system in question. In the second model the computational tool is distributed, that is, each subject can access the system. Through the language tool they represent their mental image in a common collective form. It can be handled by the subjects in a direct or indirect way, using the system functions. The last model is a distributed tool, where each subject interact through an unique language supported by the environment, or, in a general case, through the self language of each other, representing their mental image in the computer. First in an individual form and then after to a cooperative form which reflects these "individuals representations". That is, we can observe as many representations as the number of subjects that are part of the environment.

This paper is a summary of a part of a Ph.D. work that the first author is undertaking [Behar and Costa 96a], [Behar and Costa 96b], [Behar and Costa 96c] and [Behar and Costa 97] in order to focus on the analysis of the different elements that are involved in a cooperative computational environment. With this purpose, we constructed some interaction models that can be used to help organize the development of a logical-operatory method for analyzing in detail the operations that can be executed by subjects participating in a group, interacting with each other through a cooperative computational tool.

We're going to base on the interaction models that we described in the full paper [Behar and Costa 97] the construction of an operatory analysis method in a collective level in the same way that we did in an individual plane.

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Jump-Starting the Use of Technology in the Humanities Classroom

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Abstract: This paper presents a unique method of encouraging faculty at a small liberal arts university to develop multimedia learning strategies. Our model is based on the premise that faculty are best equipped to teach and mentor one another. At Fairfield University, an interesting experiment begun four years ago, involving eight faculty from a variety of liberal arts disciplines has grown to a group of over forty active faculty from nearly every university discipline. These forty-plus educators are using computers in the classroom in ways as simple as electronic blackboards to ways as sophisticated as digital video. This paper analyzes the growth of this project and explores some of the factors that have contributed to its success.

I The Problem

Television has been with us for more than fifty years, and has yet to find its useful place in education. "Higher education spent billions of dollars on computer equipment during the 1980's. [But]. . .current studies indicate that the use of computers for instructional purposes has not yet hit the mainstream of university education." Despite the enthusiastic promotion of all sorts of technology for business, communication and entertainment, educators are only beginning to use technology in the classroom. Why is this so?

Researchers have explored such factors as expense, faculty incentives and the technical orientation of various disciplines in an effort to explain this reluctance of faculty to use technology in teaching. In humanities education the lack of creative applications of technology is especially obvious. But, does it have to be this way?

II Growth

In the summer of 1993, eight faculty at Fairfield University began informal discussions regarding educational applications of technology and the development of resources and projects for the use of technology in the University's classrooms. The group's organizers met with the university's vice-president for administration and outlined a proposal for the development of resources to support this initiative. They were encouraged to work with University Development to explore possible avenues of funding, and this cooperative effort led to a grant from the Booth-Ferris Foundation to create two MultiMedia classrooms and two portable classroom/development workstations as well as money for faculty workstations and training.

The University also funded from a variety of sources more than sixteen high-end workstations capable of developing several different kinds of MultiMedia projects, and the costs of a color scanner, a CD-Rom burner, sound boards, digital video boards and software needed to create courseware. Finally, a high-speed fiber-optic network made it possible for some of the group to be networked on a LAN, facilitating the exchange of large image files, digital video and training programs as well as an easy access to this information from several classrooms. By the end of that academic year, there were more than twenty faculty involved in this program.

The secret of this success may actually be attributed to the informality of its operation and the guidelines it has adopted in order to reach a clearly articulated set of goals. All members agree that the central focus is collaboration and a willingness to be generous in sharing one's expertise (no matter what the level) with colleagues. The Faculty Initiative Group (or FIG) adopted the following guidelines/principles for participation:

1) The objective of FIG is to take MultiMedia into the classroom in support of teaching/learning;
2) To further this objective, we recognize the need for faculty to learn the technology and its

applications, and to develop a competency that would reduce our need for technical support;

3) We therefore agree

  a) that each of us will develop a multimedia project that we will take into the classroom to enhance our teaching;

  b) that each of us will develop a particular specialty (or set of specialties) which we will be willing to make available to our colleagues if and when they need support;

  c) and that we will dedicate ourselves to collaboration and support of our colleagues in developing and sharing the application of multimedia resources, models, programs, classes and techniques.

4) The purpose of this initiative is to develop adequate resources for the use of MultiMedia in teaching Fairfield University students

III Discoveries

It became clear from the beginning that there were factors working against this time-consuming enterprise. For example, it is very difficult for young faculty to get involved simply because there is little or no value attached to this work for tenure or promotion. The academy is still suspicious of technology -- will it take my place? -- it is used to "babysit" a class! -- it requires no scholarship to create or use.

On the other hand, Faculty are often reluctant to work with non-faculty media experts for a variety of reasons:

a) Traditional attitude -- the classroom is my domain;

b) Courseware is very specific to discipline and class;

c) Professors are the content experts, but at the University level, they are also the presentation experts because of the complexity of the material/ideas;

d) Faculty experience often is that media experts seem not to understand the real complexities of the educational process -- that it is more than the delivery of ideas

e) Media experts often "sell" a particular style that does not suit the classroom techniques of the professor.

At a small university, financial restrictions often prohibit the development of technological teaching devices by professional experts. But our experience at Fairfield suggests an effective approach: that a self-selected group of faculty members from different specializations, when properly supported, can develop sophisticated teaching technologies if they are brought together in a congenial and cooperative fashion.

IV Findings

One of the major concerns of the group has been to question where/how the educator fits into the multimedia paradigm. Are we "engineers" running the train? Are we "objective scientists" experimenting with reality? Are we "innocent bystanders?" Or perhaps are we part of the experiment ourselves?

Communication is important for collaboration. Members of FIG meet on a regular basis every two or three weeks (usually over lunch) to discuss current projects, future plans, policy issues and needs. At these meetings they develop ideas and discover multidisciplinary connections as well as discuss the pedagogical issues surrounding student learning and new technology.

Communication does not take place simply because it is supported; communication takes place when faculty members perceive it as a value because it contributes directly to the teaching process. This cross-disciplinary dialogue encourages the teacher and enriches the program much to the benefit of the student. Thanks to this dialogue, the teacher cannot be distinguished from other learners and in fact finds him/herself in what can only be described as a "situated learning" environment. The experimenter is part of his/her experiment.

In addition to these meetings, faculty gather together for "FigDemo Days" at which we share ideas and some of the group present their current projects. We invite other segments of the university community to come to

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these presentations to "look over our shoulders" and to participate in the ensuing discussion. This leads to a greater spirit of cooperation within the community, gives ownership to more people and ensures a greater chance for success because more people want it to succeed and see themselves as involved in the primary purpose of the university - - to educate the students!

V The Present Outcome

As we look to the next academic year, two critical factors stare back at us: first, the fiber-optic network has raised the hopes of the university community for easy communication and access for all to the information superhighway. Commitment to digital imaging and to faculty-authored courseware requires an easy electronic path to the classroom. Just as an adequate workstation makes the use of multimedia possible, so an adequate network makes the transportation of multimedia to the classroom possible.

The second "critical factor" is the need for training beyond the basics which includes not only computer literacy and advanced training in such authoring tools as ToolBook or Compel, but ethical behavior and on-line etiquette as well. We note that the culture of the university is being changed by this technology and so it is an issue for the entire community, faculty, staff, administration and students.

Finally, it is imperative to keep in mind that we are educators and that the focus of our activities must be the student. As we add the complexity of electronic interactivity to our repertoire of educational strategies, it becomes easier to focus on the process rather than the content of education. Communication does not take place simply because it's possible; communication takes place when people perceive it as a value because there is something about which they need to communicate.

The Hyperlanguage Project: A Work-in-Progress Report

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Abstract:
The main aim of *The Hyperlanguage Project* is to try to make use of some modern network (WWW) resources in today's academic teaching. Having a great potential in the fields of learner autonomy, individualization and internationalization, this idea is now being realized in the Department of English, Göteborg University through the development of an interactive on-line system for foreign language learning. The system consists of a local network platform which is based on the WebSTAR/West server software. It is designed to house a couple of IT-adapted courses with matching self-practice packages, where the course material has ample connection to various data, tools or other functions available on the Internet. The target teaching/learning units are two proficiency-related subcourses for first-term students of English – contrastive grammar and written proficiency.

1. Introduction

In the project to be sketched here, we try to take on some of the noted problems of undergraduate education in Sweden by making use of the pedagogical potential of the virtual university. The main impetus for venturing this is our realization that modern IT-technique is equipped with great educational possibilities which makes it likely to yield good results in terms of key notions such as the following:

(a) problem-oriented learning which promotes activity and creativity
(b) individualized learning with regard to pace and content
(c) stimulating setting which arouses curiosity
(d) knowledge which is both world-oriented and fresh
(e) intensified contacts between students and the external world
(f) transition of teacher functions from teacher/lecturer to mentor/supervisor

For these reasons, we have launched a two-year project – *The Hyperlanguage Project* – in the English department at Göteborg university which has the goal of developing and testing an interactive on-line system for foreign language learning.[1] Our work aims specifically at two proficiency-related subcourses for first-term students of English – contrastive grammar and written proficiency – where the intention is to compare in scientific manner the effects of IT-based learning with its traditional counterpart.

2. Build-up

The technical part of the system is realized through the implementation of a local network platform which is based on the WebSTAR/West server software. It is designed to house a couple of IT-adapted courses with matching self-practice packages, where the course material has ample connection to various data, tools or other functions available on the Internet.

Among the resources offered, databases and related information sources predominate. Thus, corpora of various kinds provide authentic examples of current grammatical patterns and idioms – sometimes based exclusively on language samples from the 1990s. Electronic dictionaries come in useful with regard to various aspects of lexical usage: their main function is to provide rapid and up-to-date information about current terminology, an effect which is often difficult to achieve with traditional dictionaries because of their publication lags and inherent limitation of search possibilities. Moreover, there are connections to a set of automatic language tools which may be of service in the different phases of language work, primarily in the description of language structure but also in the proofreading and editing of texts in general. These functions are performed by sophisticated parsers and checkers, which tend to facilitate much of the individual work with grammar, spelling, lexical choice, etc., thereby paving the way for further student autonomy. Finally, the resource collection contains a handful of teach-yourself courses and a rich collection of general, encyclopedic databases.

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[1] Thanks are due to the Arts Faculty, Göteborg University and the Swedish Ministry of Education (DUKOM) for generous sponsoring of the project.

The self-practice packages, in their turn, consist of a collection of support material for the IT-adapted courses which resemble conventional CALL modules, except that they are network-based and provide automatic feedback facilities. They find their place in the handling of any individual language problems which may come to the fore in the students' regular course work, specifically such showing a tendency to represent idiosyncratic gaps rather than general trends in their underlying language competence.

3. Testing

With the basic build-up of the system approaching completion, we are currently entering the second phase of the project work – the testing of it. This phase will begin with a spell of informal pilot testing during which possible technical and pedagogical problems are sorted out, and will then be extended to a regular running of the selected courses in the curriculum for a period of (at least) two terms. The following matrix gives a rough outline of the pedagogical design of the project:

Contrastive grammar	Written proficiency
(1) IT-learning (test group: 10-15 stud.)	(2) IT-learning (test group: 10-15 stud.)
(3) traditional teaching (control group: 10-15 stud.)	(4) traditional teaching (control group: 10-15 stud.)

Apart from the possibility of making controlled comparisons between IT-learning and its traditional counterpart, this paradigm has the advantage that no departure from existing course plans is necessary. When testing the system, we intend, generally speaking, to put in a great deal of effort to balance out as many variables as possible. In this way, the combination of method and tool in the learning process is likely to be isolated as the main dependent variable, which poses as a guarantee for proper experimental conditions in the comprehensive evaluation of the results which will be carried out.

Benchmarking Decision-Making for Distance Education at U.S. Colleges and Universities

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Administrators at conventional four-year colleges and universities are besieged with increasing costs and competition, as well as declining or degrading resources. One of the more popular solutions has been to increase institutional efforts in the area of distance education. Popular in that it has gained political favor, and--under the right circumstances--can be cost-effective and efficient. Additionally, the research is clear, the learning outcomes of distance education courses and programs can be as good as, sometimes better than, conventional face-to-face instruction. The number of students now enrolled in distance education courses at the post-secondary level is at an all-time high [Moore 1995].

What seems to be missing in the euphoric rush to create distance education programs at conventional four-year colleges and universities is a regard for whether or not, under a given set of circumstances, distance education is the right answer, and why. Just as any other "magic bullet" that has been advanced in education over the past several decades, distance education has its strengths and limitations. It is not, nor is any one answer, ever the panacea to all of the issues confronting today's college administrator.

While research in distance education is relatively new [Holmberg 1987a], there has been a tendency to focus on media comparison studies and the role of the learner in distance education (e.g. [Harris 1995]; [Kember 1989]; [Wilkes & Burnham 1991]; [Whittington 1987]), with little work being done in the area of decision-making [Schlosser & Anderson 1994]. However, the research that has examined distance education planning and decision-making tends to proffer the warning that there tends to be an emphasis on distance education delivery systems and little, if any, attention to planning activities early in an intervention ([Chander 1991]; [Hayduk 1994]; [Rumble 1986]; [Verduin & Clark 1991]). [Holmberg 1987b] encapsulates this concern when he states that "all too often, however, those charged with setting up a distance education system are not given the choice to recommend against it."

For this study, distance education was said to exist when the learner and the instructor are separated, a medium or media of communication are employed and an educational institution is involved. The method, including the means by which benchmarking partners were selected, was developed primarily from the work of [Camp 1989] and [Spendolini 1992], and included four primary stages: determining what to benchmark, selecting the benchmarking partners, determining data collection procedures and collecting the data, and data analysis.

Using the rubric of benchmarking for best practices for the essential methodological structure, the following are the results from each stage. It was determined that the focus of the study would be to benchmark the decision-making strategies--as used by outstanding four-year colleges and universities in the United States that offer at least some courses or programs via distance education--which determine whether a program or course should be offered by means of distance education. Three institutions that met the definition of the above population were selected. Benchmarking partners for this study were: the University of Nebraska-Lincoln, The Pennsylvania State University and the University of Kentucky. Data were collected from a review of the literature, distance learning consultants and professional organizations, site visitations, telephone interviews, the gathering and inspection of physical artifacts and personal interviews at each institution. The study was conducted between January and September of 1996.

There were several common salient issues that emerged from the benchmarked institutions in terms of their approaches to decision-making in distance education. Given the frequency and global nature of emergence of these issues or themes across the institutions studied, it seems appropriate to identify them collectively as a "best practices" method. These issues were: the importance of needs assessment; involvement of key personnel in the decision-making process; the assurance of academic quality and instructional validity of courses or programs offered at a distance; the certainty and quality of support mechanisms for the unique needs of distance students; and a commitment on the part of the institution to distance education.

Needs Assessment

Each institution studied noted the necessity to conduct proper needs assessment as a means of determining demand for current course and program offerings as well as exploring possible new courses or programs. It was also seen as a fiscally sound approach to developing and improving the distance curriculum at these institutions.

Distance education is often regarded as a income-generating component at a public university, and is likely to be self-sustaining. Given this fact, and the expense of distance education, particularly with the emergence of new, and expensive, technologies, proper needs assessment is critical to avoid costly miscalculations of whether a course or program will be successful.

Involvement of Key Personnel

At each of the three benchmarked institutions, members of the academic department or college were always involved in the decision as to whether or not to offer a course or program at a distance. At each institution, there was a service unit responsible specifically for distance education. At all of the institutions, both of these entities were involved in implementation, and at two of the three, both were always involved in the initial decision-making.

Academic Quality

Each institution classified the academic department or college decision-makers as the most important in the decision-making process. Each school involves these individuals in all phases of decision-making, design and implementation, and each alluded to the fact that having representation from the distance arena on academic policy boards or committees, or having a member of the distance organization with the rank of dean was seen as lending importance and academic credibility to the practice of distance education on their respective campuses. Further, each institution only allows personnel with faculty status to teach courses at a distance.

Administrators at each of the institutions studied revealed that a perceived strength in their decision-making process was careful attention to the instructional design of the courses they offered at a distance. Among the design issues that emerged as the most critical were appropriate selection of instructional delivery systems (specifically, choosing those that were responsive to the course content and the unique needs of the individual distance learner), feedback strategies, secure and equitable evaluation methods and the establishment of strong communication links between the instructor and the learner.

Support Systems for Distant Learners

Students who take courses or are involved in programs at a distance have special needs. Typically they are taking a course at a distance because they are time- or place-bound, and do not have the opportunity to take classes at a central campus location. Students should be able to conduct the administrative tasks at a distance as well as take courses. At the institutions studied, learners are able to register for classes and buy books either on-line or over the phone. Communication with advisors, instructors and classmates is often handled by phone, FAX, electronic mail or a combination of these technologies. Especially for graduate students, access to research is a critical issue. By providing access to the university's library holdings on line or through direct contact with library and media personnel at other institutions or communities closer to the distant learner, these institutions are able to provide access to quality research materials.

Institutional Commitment

Commitment on the part of the institution to provide support as well as resources to distance education instructors, administrators and students is a crucial element to the success of distance education interventions. One way each of these institutions expressed commitment to the process of distance education is the fact that it is policy not to distinguish a course taken on campus from a course taken at a distance on the students' official transcripts. Another commonality of each of these institutions in their processes of decision-making is that it is tied to the university's mission. Finally, each institution developed an organizational structure to support distance education that included a service unit or agency with distance education as its central function. This central agency serves the institutions by centralizing distance education expertise in advisement, delivery and technology.

Conclusion

It is therefore recommended that the decision-making process as to whether or not to offer a course or program at a distance should initially include addressing these questions: How does the use of a particular distance education intervention impact the mission of the institution? Is the program or course being delivered via an appropriate distance education delivery system? Are there sufficient and appropriate resources available to address the unique needs of the distance learner? The answers to these questions should give the decision-maker or decision-makers an initial reading on whether a particular program or course should or should not be offered at a distance.

Abstract

Using benchmarking for best practices as the primary methodological structure for this study, the author investigated the decision-making practices relative to distance education at three universities in the United States: the University of Nebraska-Lincoln, The Pennsylvania State University and the University of Kentucky. When determining whether or not to offer a course or program at a distance, the aggregate data suggested a best practices approach to decision-making. Among the primary issues which emerged from the study were: the importance of needs assessment; involvement of key personnel in the decision-making process; the assurance of academic quality and instructional validity of courses or programs offered at a distance; the certainty and quality of support mechanisms for the unique needs of distance students; and a commitment on the part of the institution to distance education.

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The Story Behind the Development of the Television Distance Education Course Computer Hardware and Software Components

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Abstract : In this paper, the author first summarizes the content of the television distance education course Computer hardware and software components (Organisation matérielle et logicielle de l'ordinateur). Then, she explains the story behing the development to make sure to be successful with this kind of teaching material. She concludes with observations concerning the dreamers and the doers.

1. Introduction

The Computer hardware and software components distance education course aims at giving a fundamental knowledge related to computer hardware. It is part of several undergraduate programs of the Computer science Department from Université Laval. The main goal of the course is to allow the students to understand how a computer with its various components works to be able to advise its clients or employer concerning the best configuration and to the most relevant peripherals for a particular computer use, to make the most of the computer capacities and of the computer programming activities and to be able to react quickly and properly when a computer breakdown happens. Several parts of computers are explained within specialized books and one is used as a mandatory one [Zanella and Ligier 1993]. However, as we observed that the students were able to explain those parts with their properties when taken separately but, were not able when they were confronted to "a particular computer use" such as a flight simulator or an automatic banking machine, etc., it was decided to use learning technologies. Thirteen television programs (documentaries) were added to present several "particular computer uses". The content of one television program is first summarized. Then, the story behind is summarized and finally comments on the life within the unstable domain of distance education are made.

2. The content of the third television program

Within the third unit written material [Zanelli and Ligier, 1993], students learn how fractional and floating-point numbers are represented within a computer and how it does calculation. The television program three entitled "Using the chips" was designed to give emphasis to the fact that hardware and software are two concepts that should not be dissociated. In the first part, a computer professional from the CGI Consulting Group gives the particulars of prototyping (First image at [Fig. 1]). Then, we are in Montréal IBM office with a computer professional who shows and explains all the hardware and software components of an automatic banking machine [Fig. 1]. The intent was to prepare the students to consider simultaneously the hardware and software problems when proposing a solution to their employers or clients.

3. The story behind

As tele-learning, distance education, etc, are fashionable, the administrative personnel of universities wants to compete so, asks for this kind of teaching and learning material. As there is no evidence (as example concerning the "best" way to teach an attitude (such as be cautious when advising a client or an employer), a concept (such as how some specific parts of a computer work), etc.) in regards to distance education so, what do you do to avoid a failure? You have to duplicate the way you are presenting a content to offer a variety of teaching and learning strategies.

Figure 1 : Three images coming from the television program three.

The "variations" for the Computer hardware and software components course are the following: 1- A mandatory book [Zanella and Ligier 1993] that presents the fundamental knowledge; 2- A course notebook [Marchand 1996] using other terms and examples to precise the fundamental; 3- A study guide [Boulet and Marchand 1996] that details what to do, how to do it, what are the learning objectives of each activity of a particular learning unit and why it is useful to learn that considering the workplace needs; 4- Thirteen television programs (documentaries) that are presented on cable television. They can also be seen at the library of the University. Any student can have a copy of them if she or he pays the fees of videocassettes; 5- Lot of exercises with their solutions in the written material; 6- Lot of exercises without their solutions that will be solved during special activities; 7- Electronic version of the learning and teaching materials; 8- Special activities that can be done in a classroom with the professor solving the exercises in front of the classroom in accordance with a precise schedule, or anytime via Internet either alone or with a small group of students linked to the professor, or on appointment at the professor office, or by solving them alone and sending the solutions either by mail, email, fax to the professor to have her or his comments on paper; 9- Graded exercises; 10- Two class exams that can be done either in the University, or in a remote site, or under the official supervision of someone that exercises a liberal profession; as it is not sure that every students have the exam done at the same time, several versions of each exam must be prepared; 11- Individual links with the professor to obtain help and additional explanations using either the phone (the professor has a page), the fax, an appointment at the professor office, the email or any combination of these.

4. Conclusion

Because telelearning, distance education, learning technologies, etc, are fashionable, everybody have an opinion, not always based on a factual experience (the "dreamers"). As the financial resources are cut, the administrative personnel of universities are inclined to listen to the dreamers instead of listening to the doers. The dreamers have the time to promote concepts such as virtual campus, virtual universities, etc. putting the emphasis on the save of money. Those dreamers diminish the extent of the work that must be done and do not even mention the actual effect on learners. They forgot to mention the fact that you do not produce a course one time forever. Each year, you have to make some adding. The doers must duplicate themselves to be successful. They have no energy left to be able to present the reality of thing to the administrative personnel.

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Developing Instructional Design Principles for Collaborative TeleLearning

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Abstract: A project called Instructional Design for Collaborative Distance Learning is presented, which is part of the Network of Centers of Excellence on Telelearning in Canada. Its goal is to provide instructional designers with the appropriate principles and tools to design learning activities and environments for collaborative learning at a distance.

The potential of multimedia telecommunications opens the way to hybrid solutions of on-campus and distance learning systems. Designing such solutions is a challenge for designers who use an established Instructional Design (ID) methodology, as is the norm in workplace education and training. This project focuses on design issues for collaborative telelearning and its applications for the workplace. Given the status of the knowledge in this field, an empirical approach is used for developing an instructional design methodology for collaborative telelearning. With respect to different design questions, learning scenarios and environments are developed and field-tested that allow design principles to be elaborated.

Extending an instructional design methodology

Methods for developing the ID principles include methods for elaborating and implementing them in instructional methods and implementing and testing these methods in learning environments. The project has initially selected two instructional methods: business simulation and science laboratory. Aspects of each of these methods will be explored through an iterative process of prototype development and field-testing in the appropriate educational setting.

In the teaching of Business Administration, a business simulation has been in use for some years in the Strategic Planning curriculum, where teams worked in a laboratory, coached by a professor or assistant, who also conducts the important briefing and debriefing sessions. Students have access to a set of actions, with a given time frame to create and try out a business strategy for each of the five given periods. After each period, all files are compiled by the simulation engine, and results are given back to students for the next period. Briefing and debriefing as well as tutoring can happen at a distance and be supported by interactive tele-presentation software and multipoint videoconferencing. A Web-based called NetStrat has been developed, with teams interacting on the network in real-time, thus giving students a better sense of reality. Data collection tools have been prepared and used for a first field-testing, consisting of structured diaries, computer trace files, video recording, and semi-structured interviews. These tools will be refined for further field-testing, in order to allow interpretation of data from multiple and multimedia sources. (See Bourdeau & Winer, 1996).

The science laboratory is seen as central to science teaching by those who believe that it promotes positive attitudes toward science, scientific attitudes, scientific inquiry, conceptual development, and technical skills. As a learning environment and an instructional strategy, the science laboratory includes practical work within planned learning experiences taking place in a purposely assigned environment (Lazarowitz &

Tamir, 1994). The important aspect of a learning lab is the controlled nature of the actions and the environment which permits generalization by the students beyond the specific instance under study. The context of a collaborative science learning laboratory for distance education adds the challenge that the students are not in the same physical and temporal space as their teammates and their teacher. This creates a particular set of needs and constraints for the teaching and learning environment. The Centre Collégial de Formation à Distance (CCFD) is providing a Distance learning System for the implementation of a lab for learning science in a distance collaborative mode. Data collection tools will consist of structured questionnaires, and semi structured interviews.

Toward the modeling of Collaborative Telelearning

Collaborative telelearning events can happen in environments that can support them, i.e. that have: (a) the completeness of distance learning systems, (b) flexibility to support synchronous and asynchronous (3) interoperability, (4) robustness. Such an environment is under construction at Télé-université (Paquette et al., 1995). Generic ID processes are specified for multimedia teletraining, and collaborative telelearning is considered as a set of use cases in this modeling system.

Artificial intelligence in education has several techniques to offer collaborative distance learning. Three of these -- learner modeling, cognitive diagnosis and dynamic pedagogical decision-making -- are being investigated. Instructional planning, as defined by the application of artificial intelligence planning techniques in education, is aimed at providing dynamic pedagogical decision making. The planning and decision making is dynamic in nature due to the constant updating of a learner model as the learning situation unfolds. Although typically used for one-on-one tutoring for content selection, deciding how to deliver content, and provide motivation, it has recently been proposed that instructional planning is applicable in collaborative learning environments as well (Vassileva & Wasson, 1996). Cognitive and affective goals will be augmented with collaborative goals such as facilitate collaboration, suggest peers for effective collaboration, or address feedback to the collaborative team and instructional planning rules such as if the partners in the group are not collaborating, then give group feedback and encourage them to work together are being identified.

The challenge in this project is to build and validate instructional design knowledge for collaborative distance learning, describing how to specify interdependencies between actors, processes and tasks, how to orchestrate distributed cognitive activities, how to design instruction based on interdependencies and sharing. Collaborative telelearning has the potential to reduce a student's isolation in distance learning, and the limits will then be only the creativity of instructional designers in using networks as cognitive tools for supporting socially shared cognition, and in using technologies as instruments for change in education.

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STATISTICS VIA GOAL-BASED SCENARIOS

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Abstract: At Spelman College, the Multimedia Mathematics Education Research Group (M^2ERG) is developing an interactive learning environment on Statistics by using goal-based scenarios as its theoretical framework. The theory was developed by researchers at the Institute for Learning Sciences (ILS) at Northwestern University. This project will have a CD-ROM as its final product, and the CD-ROM will be designed for both the Macintosh and PC platforms.

The vehicle for the learning process is the marketing of a product and the user will encounter various statistical methodologies in the process. Finally, the project is aimed at students who are enrolled in Mathematics for Liberal Arts courses as well as high school juniors and seniors.

INTRODUCTION

In June, 1990, thirty nine individuals representing universities, colleges, business, industry and consulting firms attended a conference at the University of Iowa which addressed the problems in statistical education. (Hogg., et. al. 1992). The participants came to the conclusion that a major overhaul was needed in order to take subject matter that is not a favorite of very many students, and make it an understandable and lively endeavor. The group stated several reasons for the undesirable condition of statistical education. Some of the reasons given are as follows: (1) statistics teaching is often stagnant, and statistics teachers resist change, (2) techniques are often taught in isolation, with inadequate motivation and with no connection to a philosophy that connect them to real events, and (3) there is also failure to use the wide variety of simulations, experiments and individual or group projects which can make statistics come alive while simultaneously enhancing student understanding.

GOAL-BASED SCENARIOS

The theoretical framework for our project is goal-based scenarios, a theory that was developed at the Institute for the Learning Sciences (ILS) at Northwestern University. The main thrust of a goal-based scenario is to use target skills in the form of a cover story and then define a mission or task that you want the user to accomplish. In our project, the target skills are statistical in nature, the cover story is the marketing of a new breakfast cereal, and the mission is to successfully sell the product in the marketplace. Another way of viewing the above is that the user will be learning by doing.

INSTRUCTIONAL DESIGN

The instructional design phase of our project has been an integral part of the entire project. Our approach is to have a brainstorming session on how we would like to present a statistical technique and then lay it on the table for critical discussion. The process has been very fruitful because M^2ERG is a mixture of students and faculty. The students in our group have promulgated ideas from the perspective of the potential users of our CD-ROM. That is, they have come up with the product that we are marketing (breakfast cereal); potential animated characters that may be appealing to students; and they have rejected ideas that would be boring for teenage high school and college students. In this process, we decide how we would like for screens to look, and then we sit down at the computer and make the ideas come alive.

The main development tool for the project is Authorware 3.5. The components are graphics, text, animation, sound and video; and the storyline is the marketing of a new breakfast cereal. The user of the CD-ROM will be hired as a marketing professional and his or her job will be to promote this product in the marketplace. In the process of promotion, the student must use statistical techniques to make decisions relative to pricing, potential customer base, shelf space in supermarkets, and other facets of the marketing arena. The user will be awarded for a good performance, and criticized on failure to move the product. The idea is to put the statistics in a real world setting and show that decision making is a major use of statistics in the workplace.

TECHNICAL ISSUES

In any multimedia project, there are several technical issues that the developers must confront. A major technical issue for our group has been cross platform development. In essence, all of the group's work is via a power macintosh machine, but we have to be aware of the problems surrounding the use of our product on a windows-based machine. Thus, we have a technical consultant whose expertise is cross platform development and the preparation of files for use on multiple platforms.

CONCLUSION

Our goal is to have the CD-ROM completed by August, 1996 for both the windows and macintosh platforms. We will also write documentation to accompany the software. The next phase of the project is to pilot the CD-ROM with selected high schools and colleges and then evaluate the effectiveness of the instruction. We plan to commence this evaluation in the Spring of 1998.

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3. Video footage was a production of the Media Center at Spelman College.

Developing a Multimedia Template for Classroom Learning of History and Geography

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The development of new multimedia technologies has stimulated considerable discussion and research into how they can be used for education. Some programs focus on using the computer as an instructor, while others use the computer to simulate experiments and experiences. Still other programs try to reinforce student learning by providing a variety of routes to the same information along with opportunities to explore the topic at greater depth.

The approach we are following advocates using the computer as a tool for student learning through doing. This is an approach exemplified by the Computer as Learning Partner project at Berkeley (Kirkpatrick 1995) and at the Institute for the Learning Sciences at Northwestern University.(Shank & Cleary 1994) In addition, we are developing our program using off-the-shelf software, an approach that has been investigated by the RAND Corporation. (McArthur et al 1994)

Our program is a template for learning history and geography. The interface is a topographic map of the state of New Mexico. The map serves as a gateway for files that contain historical and geographical information about places and regions within the state. These files can be developed and compiled by the students and then presented either locally or through the Internet. The files can contain text, maps, photo images, sound and video.

We developed the first version of the template using Adobe Photoshop and CorelDraw. We then assemble the program using Authorware. The photographs were digitized by Seattle Filmworks, and further rendered using Photoworks and Corel Photo-Paint. The topographic map was developed from satellite photographs by Ray Sterner at Johns Hopkins University.((http://fermi.jhuapl.edu/states/states.html) The textual material is based on standard reference works.

All of these programs are commercially available, widely used, and affordable for colleges and schools. We feel this is very important. Students should be exposed to the software they will encounter outside of school and, at the same time, the costs to the schools need to be kept at reasonable levels.

Using this template, students can learn history by doing the same things that historians do. They collect material relating to the past, organize it, assess its significance and present it. Once the project has begun, it can continue indefinitely. It can also be linked to other similar projects around the world. (Cole 1995) (http://www.stg.brown.edu/projects/WWII_Women/tocCS.html "What Did You Do In the War, Grandma?")

Direct learning by the students is accompanied by indirect learning. In collecting materials for the program, they discover the varieties of meaning in historical artifacts. They also confront the many interpretations that individuals develop concerning past events. They thus can begin to develop a deeper appreciation for the historians' task .(Rosenzweig 1995)

Additional learning develops about the computer and its programs. Students learn the programs by actually using them. They also confront the limitations of the computer as they attempt to use it for communication and presentation.

At the same time as the students are learning about history by creating these documents, they also learn about computers and computer programs by using them in the same fashion as they are used in the real world.(McArthur et al 1994)

Developing the materials for the original version of our program was relatively straightforward. The graphics and sound editing programs were fairly simple to use. However, once it became time to assemble the program we discovered that Authorware was not very friendly. In addition to difficulties in programming, we found that the Authorware version we were using was not well-adapted for straight presentations. (More recent versions of the program have resolved some of these difficulties.)

It was apparent that Authorware was not a program suitable for classroom use by teachers and students. It simply takes too long to master.

A second version of the program was developed using HTML as the mark-up language. This proved very successful and simple. We used a shareware program from the Internet to perform the basic mark-up. We created the map interface using another piece of shareware, MapEdit, which is free for educational institutions.

This process was very straightforward and inexpensive. We had to drop the use of video and sound files, simply because they took up so much memory space, were difficult to render (the video, especially) and because our current server doesn't allow for video loading at present. However, the final project fits on a floppy disk and is easily downloaded. Moreover, because of the nature of HTML, students and teachers can simply take ou program and insert their own material for ours, leaving the basic structure intact.

In developing this version of our project, the most difficult task was mastering the "tables" function of HTML. The tables function allows us to have some control of the positioning of elements on the screen. Now that we have created the base document, others can simply cut-and-paste from our program to create their own.

Finally, in the second version of this project, we gave more attention to questions of effective design.(Hoadley and Bell 1996) We wanted to create a template that would be easy to use, yet provide the user with an attractive appearance and easy access to navigational information about the rest of the program. In developing this version, we relied heavily upon the design guidelines developed by Yale University Medical School's Center for Advanced Instructional Materials. These materials are available over the internet at http://info.med.yale.edu/caim/stylemanual.

In conclusion, it appears to us that the internet and HTML based programming offer an ease and simplicity of production which other multimedia tools lack. The ability to find and "borrow" ideas and templates from a wide variety of sources is another benefit of web-based multimedia.

Our nest step in this project is to disseminate it to teachers and schools and begin assessing its effectiveness in a classroom setting.

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Activated Scientific Knowledge and Education

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Abstract: This paper outlines the development, methodology, and philosophy, of the PolyMath group's M3/Plexus project. Our goal is to use new technology, such as Java, to create a seamless learning environment appropriate for a fully collaborative virtual classroom, and for tele-learning and distance education methodologies. We propose to integrate the plethora of currently available resources and technologies in order to form an integrated computational environment which is flexible enough to accept future resources as they become available, simple enough to be used by non-experts, and accessible to more schools and colleges.

Introduction

Since the beginnings of mathematics education, there has always been a form of interactive learning and of interactive mathematics. Whether the teacher approached the student at her desk, or illustrated a concept on the blackboard, the student has always has the opportunity to ask questions and seek alternative answers. The answers have often been sought by a modification, by the student, of the information presented on a blackboard. This interaction with knowledge is crucial in learning, and forms a major part of the human relationship between student and teacher. As we move into this technological age where distance education and electronic textbooks become important means of education, we must ensure that we preserve this spirit of student/teacher interaction and student exploration.

We believe that distance education can be, and must be, more than a fancy electronic classroom. The power of the Internet, combined with an intelligent development and dissemination of sophisticated platforms can challenge the ways we currently teach and do mathematics. Students will be able to participate in their own learning and discovery processes, be guided into building problem-solving strategies, and given access to the same tools that a research level mathematician might use. One goal of the PolyMath group's M3/Plexus project is to provide an integrated yet broad spectrum of experimental and visual explorative tools which can make mathematics live and exciting for our students. And, because mathematics is the language of all the sciences, such platforms can be as valuable to a student of physics, biology or chemistry as they are to a student of mathematics.

Phase I

The first phase of the Multi-Modal Mathematics (M3/Plexus) project was the Organic Mathematics Project. {http://www.cecm.sfu.ca/projects/OMP/} This was an experimental investigation of the concept of activated mathematics, in which mathematical documents become "live" entities on the World Wide Web (WWW). They are connected to each other, to algorithms for live mathematical works, and to resources elsewhere on the Web. They contain hypertext links with a variety of media tools (audio, video, animation, text), advanced interactive mathematical tools, and an annotation tool which promotes communication and possible collaboration among mathematicians. Although this Project was primarily intended for research mathematicians, we were forced to reflect upon many of the issues involved in creating a seamless learning environment.

It became apparent that merely designing tools for exploration and manipulation was an insufficient approach to supporting a problem-solving environment in which the student is actually engaged in "doing" mathematics, i.e. asking their own questions.

We also discovered that a simple annotation system does not satisfy the need for the intuitive communication design required in a distance learning environment. It is not sufficient for students to be able to annotate and comment, they must be able to communicate in real-time using equations, pictures, and formulae. Nothing is more discouraging to a student than having someone try to explain math in words or having to interrupt their thought processes to wait for help. Moreover, the teacher must be able to follow the student's reasoning in order to effectively guide the student -- to transfer experience and intuition rather than answers.

This demand for flexible forms of data for the mathematical sciences presents enormous challenges. There are already sophisticated pieces of software that support this, yet they remain inaccessible to most schools and colleges, and they remain in isolation of other essential mathematical tools.

Goals

We would like to develop a set of strategies for linking these tools together -- to aggregate, activate and deliver mathematical resources in order to provide a coherent, engaging, flexible environment. We must cater to the huge gamut of different computational platforms, and mitigate the need for users to purchase expensive pieces of hardware or software. This is truly essential, for knowlege and education must be easily available to all, independent of ability to pay for excessively sophisticated resources. We must be careful that our technology does not foster the special education of only a rich elite of students who can afford specialized computing systems. Furthermore, It is essential that the teachers' and students' needs be driving the technology rather than having technology dictate which services or which resources are included. They must have the choice to incorporate tools at any stage within any system.

Our solution is to provide a sophisticated set of integration services, using Java and the latest distributed object technologies, that will allow us to assemble new and existing scientific educational tools into flexible educational systems. The services communicate with each other using PolyMath's Activated Scientific Knowledge through Universal Semantics} (AskUs) framework. AskUs allows for the exchange of syntactically semantically complicated information like mathematics between tools and over the network, and is designed to be implementable and useable through a wide range of networking technologies. The semantic information is exchanged via a flexible networking framework called PolyNet, which provides for encoding and decoding of the kind of relational data trees that are often used to represent mathematics, as well as the information describing the interaction between computational tools.

The PolyMath AskUs technologies allow advanced mathematical, and other scientific, tools to be distributed over many powerful computers, and for those tools to be controlled using clients, written in Java, that can be used by anybody with a current Web browser such as Netscape Communicator.

PolyNet and AskUs allow for many different environments to be created, rather than dictating a single approach to education and collaboration. It becomes up to the student or teacher to decide when or how they use different resources -- whether they choose to build a general environment or one specifically suited to individual needs. This allows the PolyMath group to construct educational solutions ranging from online educational textbooks to full collaborative environments for research-level communication between mathematical scientists.

Solutions

One example is the on-line textbook which is currently in development. It provides the student with the tools to develop a problem-solving strategy, explore databases of resources, and engage in both visual and computational discovery. A typical problem will offer the opportunity for the student to come to a more sophisticated understanding of new concepts and to apply this understanding in the problem solving procedure. The student can experiment with equations and formulae using software programs like Maple, interact with graphical displays in a familiar way and see the numerical results of their manipulations.

The PolyBook interface integrates different tools that a student could use in solving a problem. The tools themselves are interactive; the student can move the regions in the graph and the table at the bottom of the screen will change according to the configuration of the graph. Moreover, the student can use Maple to experiment with the findings in the table or on the graph. Should students want to explore a different facet of the problem -- they are free to call on another tool and continue to observe the interaction with the original tools.

The crux of the system is the flexibility of the tools which fosters a true spirit of participation, their interactivity, and their intuitive nature. The passage from one environment to another is natural and flexible. The student is guided by the framework (i.e. the tools initially available) yet free to explore the problems in many different ways.

Another example is the PolyMath online blackboard, a fully collaborative communication environment. This potentially provides a forum for student/student and student/teacher interaction, and thus for true collaborative learning, which is so crucial to successful distance learning.

A teacher can access the work in progress of a student, comment directly on both numerical and symbolic computations, provide guidance in the form of visual aids, be they illustrations or even sophisticated graphics, and respond immediately to the student's queries. The interface is completely natural in the same way that a blackboard is in the classroom with the added bonus that both teacher and student have access to powerful mathematical tools.

The student can make comments as he goes along letting the teacher know how he is progressing. The opportunity for the student to be able to communicate, to not feel isolated in the learning environment is central for effective participation. The essential tutorial component of humans educating humans is preserved.

In addition, the development of the problem, including comments, corrections, and hints, can be stored and easily retrieved. This captures the highly valuable and central creative process involved in "doing" mathematics, science, and engineering. The comments could be extremely useful to other students, and could even be used as hints to guide the work of an entire class.

Furthermore, new resources that are available on the web can be automatically integrated into this environment, so that a teacher might find an alternate way of representing a new concept for a particular student's needs, or students can call upon new tools which might help them experiment with a concept or problem. The systems provide a toolbox, from which students and teachers can build what they need.

The beauty of both these solutions is that the programs needed to create the environment sit on the network and provide the various services to the users. These services can be distributed across the network and do not have to sit on one machine. They can then be encapsulated inside an easy to use environment that avoids

Teachers needing to learn to install and use the system,
Schools, small colleges, and students having to buy the software,
Schools, small colleges, and students needing to buy high-end hardware to be able to run the software (aim: to run this stuff on low level, less than 500 dollars, hardware in the future).

Conclusion

We wish to build an integrated learning environment capable of being amenable to a variety of users. It should offer, at minimum, the following: A locally or remotely guided directed learning environment: Appropriate for K-12 and post-secondary learning. Utilizes a central master process controlling the path of clients through the subject material. An internet based research and exchange environment: Permits user to exchange, effortlessly author and integrate new and extant resources.

The idea is to distribute sophisticated computing resources throughout the world to anybody with "basic" network and computing access in a way that does not compromise functionality, and enhances education, communication, and collaboration. We want to ensure that the essential spirit of interaction and experimentation is maintained whether the learning is between students, between researchers, between a teacher and a student, or in a classroom situation. And finally, the distribution must not interfere with the preferred educational approach of any student or teacher. Technology that reduces human freedom in education should not be deployed. Education is more than static knowledge, and hence will always be more than an online textbook can deliver.

Much more is to be learned through initial trials of these environments in both the K-12 and undergraduate environments. We look forward to the imminent initiation of these trials, which in fact constitutes the next step in the M3/Plexus project.

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A CD-ROM-based Resource Kit for Instructors in the Developing World

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Abstract

A CD ROM-based instructor resource kit that uses the storage and search capabilities of the CD ROM to provide instructors with easily accessible and reproducible classroom-based curriculum frameworks, lesson plans, and supporting instructor lectures and student activities. The project aimed at providing maximum functionality to the classroom trainer as well as to the self-directed learner by drawing the recent presentation and electronic publishing technologies while time staying within the technological constraints of the developing world. All materials are housed in an object-oriented database that provides a system for managing, searching, and browsing media elements including text, audio, 3-D and video. Visuals may be projected full-screen by launching the Powerpoint viewer. Visuals and all other text materials are captured as PDF files and may be viewed, searched, and printed using Acrobat.

The Problem

How to take twenty years of trainers' knowledge and experience comprising five weeks of classroom training on project management, distill it, and disseminate it easily, quickly, and cheaply to developing countries to get the biggest multiplier effect? Filling the knowledge gap is a central concern in international development. The need for learning resources in developing countries is great; but, in many countries, technology-assisted delivery is constrained by lack of hardware, software, and a teaching culture that is based on skills training in the classroom instruction.

The Solution

The technological equivalent of putting old wine in new bottles: *a CD ROM-based instructor* resource that uses the storage and search capabilities of the CD ROM to provide instructors with *easily accessible and reproducible* classroom-based curriculum frameworks, lesson plans, and supporting instructor lectures and student activities. Instructors can use the contents of the CD in three primary ways: as a source of inspiration for course development, as a source of hard-to-find student readings, activities, and lectures for enhancing existing courses, or as a "ready-made" course which they deliver as designed. Files can be downloaded and customized to meet local needs. All materials can be reproduced using a laser printer, so the CD ROM serves as a virtual printing press for instructors, an important function in developing countries where access to copying equipment is often limited. The Economic Development Institute (EDI) of the World Bank promotes economic growth in the developing world by sharing the World Bank's expertise through networks of government officials, universities and research institutes, regional development banks, and nongovernmental organizations. Part of EDI's mission is to prepare and disseminate high-quality learning materials worldwide.

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The CD-ROM Resource Kit

Effective project management is essential to meeting time, cost, and quality objectives in the implementation of World Bank projects. The CD-ROM contains 12 modules of print-based training materials on managing project implementation. This electronic product is expected to help "wholesale" training by providing a standardized core of high-quality learning resources for students, trainers, and practitioners in developed and developing countries. It is based on a collection of printed materials used for classroom training over a twenty-year period. The CD resource kit has been designed according to performance-based behavioral learning principles and the course and module objectives support the skills required to manage projects successfully. A subsidiary goal of the project has been to develop a model for future distribution of learning resources in various media, both in print and electronically, on CD and over the Internet. The model attempts to address the training needs and the technological constraints that exist in the developing world. The complete resource kit has 12 modules: 1. Understanding the Project and Project Management; 2. Structuring the Project Organization; 3. Building the Team; 4. Analyzing the Project Context; 5. Refining Objectives, Scope, and other Project Parameters; 6. Preparing Work Breakdown Structure; 7. Planning and Scheduling with the Critical Path Method; 8. Obtaining Management Approval and Support; 9. Designing Control and Reporting Systems (Scope, Time, and Cost); 10. Organizing Procurement; 11. Executing and Controlling the Work; 12. Terminating the Project.

Content and Process

Developed to help instructors design and deliver course in the classroom, each topical module includes performance-based objectives, module and session outlines, scripted "sample" lectures and visuals, case exercises, teaching notes, solutions sets to exercises and case studies, optional readings, and a glossary of terms. Capturing these materials electronically and "repurposing" them has provided the opportunity to improve their instructional effectiveness, the coherence of the course package, the coverage of the learning activities, and the design of the printed page. This CD project has yielded an improved print-based product, a new electronic product, and a model architecture for distributing learning materials electronically on CD-ROM.

Functionality

The project aims at providing maximum functionality to the classroom trainer as well as to the self-directed learner by drawing on the recent presentation and electronic publishing technologies while at the same time staying within the technological constraints of the developing world. It is possible to search and sort the materials by topic and by type of learning resource (i.e., case study/exercise, lectures, readings, and combinations of these categories). Any material or combination of materials may be printed out on a laser printer while retaining a consistent format. Overhead transparencies may be printed out or projected in class directly from the CD. The electronic files of the lectures and cases can also be downloaded into standard word processors for modification. Alternatively the materials may be previewed and browsed on the computer for purposes of self-directed learning, although this is not the primary intent.

Architecture

All materials are housed in an object-oriented database that provides a system for managing, searching, and browsing media elements including text, audio, 3-D and video. It has a built-in navigation system that is separate from both the interface and the content, which allows interface and content to be changed easily without complicated programming. It can also be used to run Web services. Visuals created in Powerpoint may be projected by launching the Powerpoint viewer. Visuals and all other text materials are captured as PDF files and may be viewed, searched, and printed using Acrobat. Printed "lectures" may be browsed by scrolling the text in one window with visuals in an adjacent window.

Learning by Doing - Teaching Hypermedia Hyperactively

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Adult novices are very interesting and challenging to teach. In the area of computers and computer concepts, novices can be surprisingly low on prior knowledge, or else they are so filled with anxiety that any relevant prior knowledge is blocked. In either case, the teacher needs to use a variety of teaching strategies that have been proven to be effective in helping the learner construct and apply new knowledge. Three strategies were applied to the specific concept of "hypermedia": accessing and building upon prior knowledge; using metaphors in teaching new concepts; and collaborative grouping.

Strategies for Teaching Hypermedia

Accessing and building on prior knowledge is fundamental to any lesson or any activity that involves learning something new. In order to allow learners the opportunity to feel comfortable in learning about hypermedia, the first step was to examine the word "hypermedia". The learners have heard and used the word media in their everyday lives in reference to television, newspapers, and videos. They have also used the term "hyper" when referring to an unruly child or someone who cannot stay on any one task for any length of time. So a short review of these terms, combined with a class discussion of "hyper" people that the learners knew, provided a foundation of prior knowledge on which to build.

The next strategy used was a metaphor for the hypermedia program to be introduced. The software program used in this activity was HyperStudio. This program has an index card structure, so the metaphor of a stack of cards enabled the learners to understand the nature of HyperStudio.

The last strategy used in this lesson was collaborative groups. The students were grouped and given various tasks so that they could problem-solve, experiment, and construct their own meanings of the term "hypermedia". They were able to feel comfortable with the task since they were not working individually.

Activities for Teaching Hypermedia Hyperactively

All of these activities were done in a large open area. Step One: The students were divided into three groups. One group was the "New" group; one group was the "Linking" group; and one group was the "Input Data" group. The "New" group was in charge of creating any new object such as New Card, Add a Button, Add a Graphic Object, or Add a Text Object. The "Linking" group was in charge of connecting the linked objects with tape and yarn. The "Input Data" group was in charge of entering text.

Step Two: The groups were each given task cards which described what they were going to be creating. The "New" group had a stack of posterboards from which they cut buttons, text fields, or graphics. A whole piece of posterbaord was used for each card. Their first task was to create a stack with five cards, so they lined up five pieces of posterboard on the floor. Their next task was to create two text fields on the first card - one for the title of the stack and one for the creators of the stack. One group member of the "Input Data" wrote "The Three Branches of Government" in large letters in the text field at the top of card one and then wrote "Created by the Instructional Technology Class" in the other text field. Another member of the group placed these fields on card one. They could be either taped or glued. (Taping would be a more appropriate representation of a text object.)

The next task required all three groups to work together to create a button that would be linked to the next card. The "New" group created the button. The "Input Data" group labeled the button. Then the "Linking" group taped one end of the yarn to card one and then taped the other end of the yarn to the second card.

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On the second card, three buttons were created and labeled "Executive", "Legislative", and "Judicial". The groups worked together to link these to cards three, four, and five. Then a button was created and placed on each of those three cards that would link them back to card two. The "Linking" group made sure that the other groups knew that the one link from the menu card to the individual card could not be used to go back to the menu.

Other text fields and graphics were created and placed on the cards. Then each group had to summarize and report their group's major responsibilities and any problems that they encountered. This part of the process helped prepare the learners for creating a stack of their own on the computer.

Conclusion

By making a game out of the creation of hypermedia, I was able to prevent my older students from being confused, frustrated and defeated. By using this activity, I had something concrete to refer them to, if necessary, as they completed the computer task. The whole activity took less than 45 minutes and was well worth the time. One added benefit of this activity was that it developed student leaders who were confident and comfortable helping their fellow classmates. I noticed that many of those students quickly accomplished the computer task of creating a four card stack with many links, transitions, and actions. They were then able to help the slower students construct their stacks in the HyperStudio program.

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Crumbling Walls: Hypermedia Sketchbooks in Art Education

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Abstract: "Crumbling Walls" uses an experimental hypermedia program, MediaScraps, to speculate on alternative methods of sketching for media artists. It proposes that similar processes of projection and working over visual ideas, that began with Leonardo da Vinci's sketchbooks, can occur using hypermedia scrapbooks and collaborative computer archives. Features of the software, designed for an intranet, are descibed as well as the educational context of using it. The program's purpose is to help foster ideas --- not in producing finished work. However, this "secondary" medium raises primary questions on the nature of personal and public expression.

An important task for art education is to encourage methods, means and spaces where developing artists can work out their ideas. Sketchbooks, scrapbooks and diaries are perhaps the most ubiquitous and wonderful portable accoutrements of the visual artist. They constitute the ready-at-hand sidearm drawn not at precise, preexisting targets but rather at the fuzzy aims and purposes which are always in a state of becoming.

The practises of sketching that transcend planning purposes and go further into the primary creative process were invented by Renaissance artists. E. H. Gombrich points out that Leonardo Da Vinci's notebooks suggest how artists might adapt drawing to new purposes: away from the exactitude and specifying of medieval form and towards more open processes of perceptual and conceptual discovery.[Gombrich 1966] Leonardo recommended looking at crumbling walls because one could find within them stange inventions. Consequentially, he extended the experiments with walls and perceptual projection to the sketches of his notebooks. According to Gombrich, not only did Leonardo's process of discovery lead to a dreamlike loosening of controls but also to the persistence to keep on creating, never accepting any form as final. I am proposing that a similar process of projection, working over and assimilation of ideas can occur using digital sketches, hypermedia scrapbooks, and collaborative computer archives.

At the Kansas City Art Institute, my colleagues and I have long sought alternatives to traditional drawing and sketching for the students entering school and our department. We recognize that drawing is a crucial experience for visual artists, and most students gravitating toward the media arts (film, video, photography and computer art) do have extensive drawing experience from high school or within the foundation curriculum of the college. But in a media society, drawing no longer provides an absolute, universal benchmark for conceptual skills or their awareness of visual culture. We need to look at other methodologies, especially for developing students of media, to reveal the level of their visual thinking.

I am not only suggesting that the methodologies be broader, but that they be more germaine to the specific interests of the student and to the nature of the society in which we live. If, as artists, we understand that culture moves according to a logic of optical representation, mechanical reproduction and cybernetic dissemination, then the way we develop our ideas should work according to this logic as well. Without throwing away our sketchbooks, we need to find technological tools to supplement them and extend them by analogy. Looking at the personal sketchbook/notebook of art school students is a good starting point.

The prototypical art school student notebook is a medium-sized hard bound folio of white, unlined sheets. The students fills one page after another with accumulations of personal notes, lists, drafts of writing, classroom notes, diagrams, doodles, visual-amusements, pasted scraps, photographs, project scenarios, storyboards, sketches and elaborate renderings. When the pages are filled, the notebook is shelved next to prior volumes, and a new one begun.

These are trustworthy, useful and revered volumes. They a inexpensive, durable, portable, easy-to-use, and both standarized and uniquely personal. A students entire educational career and personality is encapsulated by them.

But there are shortcomings to the venerable notebook, and the aspiring media artist might wish to augment them with the power of computers and imaging technology. They would then be reconfigurable, editable, infinitely expandable, searchable, and, importantly, in a mirror-like form to media culture. Already, media artists are adapting their Foundation sketchbooks to function as repositories for their image fragments, photographs, clippings, classroom notes, and dramatic scenarios.

In the Sophomore Introduction of the KCAI Photo-Video Department, we are experimenting with a hypermedia program to erect this kind of digital scrapbook where media artists can sketch out their ideas in their own terms. Before I describe the software we have developed, a description of our Sophomore program and the events leading up to the project would be useful background.

The Sophomore program is designed to give the student all the basic skills necessary for advanced work in the Photography-Video Department. These skills include a black and white photography, color, alternative processes, lighting, large-format photography, video editing, audio, digital image editing, layout, and multimedia authoring. Besides Photography and Video, there is a third section, Media Art (which I teach) that covers computer practices as well exploring the relationship between fine-art culture and the culture of mass-communications. All sections encourage the thinking skills and independence necessary for students to perform mature, self-directed work in the junior and senior workshops.

Toward these goals (of working independently), I saw a need for ways that students could loosely organize and display their work-in-progress. In to my section of the course, observing and documenting media culture are important, and many assignments ask students to clip and digitally scan images that illustrate weekly themes, such as print-reproduction syntax, pseudo-events, changing persona in mass-celebrity, and so on. We needed a means of organizing these digital clips as well as a forum for their display. In addition, the class works in a variety of media types -- still picture, quicktime movie, QTVR, audio, and text -- so that a digital scrapbook must be as flexible in file type as in subject matter.

In the Fall 1995, I initiated the "MediaScraps" program in Apple Hypercard and Heizer Windowscript. It was designed simply as a front end and viewer for the all the above-mentioned types of digital files. A palette presenting lists of folders and files was at the center of control: simply click a folder to display its contents; double-click a file to display it center-screen. The heart of its utility was in the flexible manner that this brower works with the Macintosh Finder (through AppleScript): remove, add or rename files and the contents of the control palette instantly update to the new state of affairs. After an initial prototype, I ported the program to Allegiant Supercard, because of its integrated windows environment, menu creation tools, color support, and external software for working with directory files.

From this simple beginning, the program has evolved into a full-blooded program with a prodigious feature-set, which I will itemize: As many as four-windows can be open at open time; the pictures are scaled accordingly. The control palette can take a number of configurations: It can display the file type and file size. Icons can be displayed on the fly. The user can select a filter to list a particular file type. Importantly, user-information can be added to the files. Keywords can be added through a special window with an authority list based on categories of the course material. Students can add loose comments, too, in a couple of ways: by keying in a comment or by digital voice recording. Either form of comment is displayed or played back, respectively, by a special window along the bottom, by synthesized speech, or by regular audio playback. Comments accumulate for each file and an arrow-button permits one to browse through them. The standard suite of four windows will display any document type, but there are other windows for special circumstances. There is a "QTVR special" window that supports the full range of QTVR capabilities such as auto-panning and zooming. There is a icon window, where icons are drawn together from any folder and arranged into layouts. The icons retain links to the original files (as long as the file name and file location are not changed); slideshows can be played back, and file sets can be copied out to separate folders. Lastly, the environment is customizable with the ability to change and edit the backdrop pattern and to set preferences for the feature sets in operation.

This latter ability to inactivate certain features was called for by the need to keep the simplicity of the program's core vision: an easy-to-use digital scrapbook. In keeping with the need for simplicity, I have retained the way in which the program works with the Finder and its one-folder-deep limitation. To set up MediaScraps, you drag the program file to a folder containing the file folders you wish to access; these folders cannot contain other sub-folders. Since no file-specific data in carried by the program, if anyone desires to access another set of file folders, he or she simply copies the program to the new context.

This balance of simplicity and complexity also becomes an issue for me working as programmer at the level of code, too. The scripting of authoring tools like SuperCard offers non-professional programmers the ability to try out code and make modifications immediately. Their object-oriented structure encourages a modular approach to design and an incremental path of development toward complexity. Students continually give me feedback on bugs, features, and interface design and a number of change have been made in response to their ideas. Indeed, even at the level of code, MediaScraps retains the spirit of drafting and exploration carried on by the entire class.

In summary, in its design, MediaScraps involves sketching metaphorically by conceiving form through a process of trial-and-error, evolution of details and the counter-movement of discovering and retaining core structure. In the usage of MediaScraps, sketching is primarily a matter of montage, arranging and comparing. In the future, drawing tools can be implemented to transform graphics as well. But, there are still basic levels of "sketching" (as a metaphor) remaining in which I can draw concluding speculatons.

As a class project, MediaScraps comprises a collection of personal scrapbooks, and in its aggregation, may be thought of as an archive of diverse material.

Media artist must learn from archives (photographic, film or otherwise). Loose collections of images in archives are, in a sense, their crumbling walls. In the darkness of archives, associations may be found between items that they never had (or will ever have) in the public light of galleries or in publications. This place of faint links and sparking associations will later illuminate the screens, video rasters, or frames of regular display spaces.

Recently, I have been gratified to see specifically how MediaScraps has provided in action an archival space for issuing images into the light of day. Our Department is currently producing a multimedia work about ourselves and our work. MediaScraps is in action collecting and organizing the diverse material and content of the production. (We are using mTropolis for the final program because of its object orientation and its ease of cross-platform development.) I have adapted the program to the functions of archival management with custom database tools. In keeping with the document orientation of MediaScraps, the data is written to the resource fork of each file (as well as to an external text file for backup) rather than to the cards. There is a capable search engine that retrieves both data from the resource fork and references to the original files.

Though these database capabilities are still being developed, the archival possibilities and powers of MediaScraps are being felt. At this stage, we are considering ideas of classification, cross-referencing, and image description that are leading to the discovery of the nature of visual information and knowledge. Like an archive, MediaScraps is a practical means-to-an-end (the end being the CD-ROM) but may also be viewed, like a library, as a rich cultural artifact.

Libraries, even if private, always point to public knowledge, and this awareness leads me to speculate about the value of MediaScraps as a rewiring of the personal scapbook to become a medium of collaboration and communication among artists. The basis of the shift is powerfully embedded in the archetypal student sketchbook: a record of personal diaristic thoughts, yet also, through decorated covers, an outward expression of identity and status. Leonardos sketchbooks were emphatically personal. They were even encoded by reverse writing in order that others could not easily read them. Yet they stand as monuments to the collective spirit of innovation of the Italian Renaissance. Libraries are similary ambiguous in being places of personal and private retreat, yet they embody the most public of impulses toward social understanding of the world.

MediaScraps, similarly organizes ideas for the self but also manifests them to others. The scrapbook-archive is located on the schools central server where students can access it anywhere on the local area network (intranet). Central, yet dispersed, students have a private window on their own scrapbooks in view of those of their colleagues. They may add comments and keywords to others scraps as well as their own. In view of the changing nature of social communication through digital technology, it is important that artists develop their work at the edge of the increasingly blurred boundary between public and private life.

In conclusion, MediaScraps has shown many exiting of possibilities, but as an evolving sketchbook, there are still new ideas to explore; new lines to draw. So far, we have realised the intention of finding tools that encourage development of artwork through projection, association, collection and collaboration. But, hypermedia tools may be useful in retrospection as well. Artists statement may be used not only for self-promotion, but also for self-understanding. Already designers use portfolios on CD-ROM or Web pages to sell their wares, but educational possiblities for artists exist here, too. The future step for MediaScraps is to produce an enlightening hypermedia-form of artists statement.

-Book references:
[Gombrich 1966] Gombrich, E. H. (1966). "Leonardo's Method of Working Out Compositions," Norm and Form: Studies in the Art of the Renaissance. Chicago. 107-21.

A Study into the Future use of Synchronous and Asynchronous Technologies in the Distance ESL Education Area with an Emphasis on Collaborative Learning

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Abstract: Synchronous and asynchronous technologies can be applied to the *Teaching-Learning Cycle (TLC)* pedagogy to provide an effective collaborative distance ESL model where the focus is on learning with the assistance of technology. This pedagogy is learner centred and moves from known contexts (vocabulary, functions and grammar) to the unknown with scaffolding provided to the learner as needed throughout the course of learning. Collaboration ensures that the learner has ownership and is responsible for their learning. The translation from a one site to a multi site classroom affects the types of distance education technologies used. Research demonstrates that many technologies must be employed to effectively implement the TLC.

Using Synchronous and Asynchronous Technologies in Distance Adult ESL

The Teaching-Learning Cycle (TLC) [Hammond, Burns, Joyce, Brosnan and Gerot 1991] provides a basis and framework for planning an effective series of lessons in the language and literacy classroom. It incorporates tasks that concentrate on the social language functions of text types whether they be spoken or written. Learners learn about the language through the modelling and deconstruction of texts and by drawing on the shared understanding of the schematic structure and grammatical patterns of the text-type being taught. After much text analysis, learners jointly construct the target text moving onto independent construction when they understand the necessary text-type features. Throughout each stage of the TLC, collaboration is an essential feature. The four macro skills reading, writing, speaking and listening encompass a 'whole language' approach to ESL teaching in an integrated fashion and not in isolation.

The TLC consists of four stages with the first stage being *Building the Knowledge of the Field*. This stage provides the cultural context, shared experience, control of relevant vocabulary and grammatical patterns for the target text-type. The next stage *Modelling of Text*, provides the cultural and social function of the text. Schematic structure and linguistic features are highlighted in the target text. The next stage *Joint Construction of Text*, provides learners with a chance to use the schematic structure and linguistic features of the text collaboratively together with their combined knowledge of the field or context to practise re-creating the text-type. The final stage *Independent Construction of Text*, allows the learner more autonomy to construct their own texts using the context and structures provided throughout the TLC. In translating the teaching environment to a telelearning environment, the macro skills are incorporated into representational forms, that is, *visual, graphical, textual, aural and data representational forms*. Some of the forms are best suited to synchronous technologies while other forms function best with asynchronous technologies. To utilise the TLC in a collaborative learning environment, careful use of both synchronous and asynchronous technologies are necessary to foster effective distance learning.

The table below demonstrates how synchronous and asynchronous technologies were applied to the TLC.

Stage 1 Building the knowledge of the Field			
Reading	**Writing**	**Speaking**	**Listening**
Visual/Graphical: View video/pictures/diagrams to set	*Textual:* Brainstorm ideas as a group onto	*Aural:* Talk and share experiences with other	*Aural:* Listen to each other's experiences from

the context. *Textual:* Read a variety of authentic texts. • *Asynchronous*	a common 'white board' • *Synchronous*	members of class • *Preferably Synch.*	the class and the teacher. Listen to the text in use. • *Preferably Synch.*
Stage 2 *Modelling of the Text*			
Visual/Graphical: Review videos/pictures to identify examples of the text-type so context is reinforced. *Textual:* Read model of the text, help given to identify key features • *Synchronous*	*Textual:* Collaborate and brainstorm ideas as a group onto a common 'white board' • *Synchronous*	*Aural:* Talk and share ideas, collaborating with other members of class. In small groups and pairs discuss features of text. • *Preferably Synch.*	*Aural:* Listen to each other's ideas from the class and teacher. Collaborate by listening, sharing & identifying features of the text-type. • *Preferably Synch.*
Stage 3 *Joint Construction of the Text*			
Graphical: Small group/pair work using collaborative activities to reinforce staging of similar texts. *Textual:* Small group/pair work constructing grammatical examples within context. • *Synchronous*	*Textual:* Small group & pair work using collaborative activities to reinforce staging and grammatical features of similar text-types. • *Synchronous*	*Aural:* Small group/pair work in collaborative activities to reinforce the features of similar texts. Practise the text-type & similar text-types orally if spoken. • *Preferably Synch.*	*Aural:* Listen to each other's ideas in small groups & in pairs. *Aural:* Collaborate by listening, sharing & constructing the text-type. • *Synchronous*
Stage 4 *Independent Construction of the Text*			
Graphical: Individual activities to reinforce staging of similar text-types. *Textual:* Individual work constructing grammatical examples within context. • *Asynchronous*	*Textual:* Individual activities to reinforce staging and grammatical features of similar text-types. • *Asynchronous*	*Aural:* Individual activities to reinforce the features of similar texts. Practise the text features. • *Asynch. or Synch*	*Aural:* Listen to teacher and other's ideas. *Aural:* Individual listening & construction of the text-type. • *Asynch. or Synch*

Synchronous technologies trialed incorporating *textual and/or graphical representational forms* included shared electronic whiteboards, IRC, Livechat and MOOs. *Visual and aural representational forms* included ISDN audio conferencing and video-conferencing which allow effective but sometimes costly synchronous collaborative work. Internet based video-conferencing provided a 'form' of synchronous collaboration. Remote control programs such as Timbukto allowed further demonstration and collaboration as learners and teacher controlled each other's machines. Asynchronous technologies trialed included e-mail, newsgroups and threaded discussion forums.

It is common practice to establish protocols for any type of telelearning, it is essential to have the protocols clearly defined and understood beforehand when setting up sessions. Unfamiliarity with basic computer literacy skills such as typing need to be taken into account. Discourse problems can occur in the use of text based programs, with learners often have trouble discussing in written form The problem involves the sequencing of replies to the chat space. This is directly affected by the number of participants involved in the group. Replies arrive at the chat space out of sequence as the time lag between nodes affected transmission rates. The use of a moderator helps to address this problem. If available, one nominated person could enter the group's textual comments rather than on an individual basis. Video-conferencing can be effective but needs to be highly structured at first to allow user familiarity to overcome the discourse problems experienced with turn taking. A structure needs to be set in place so that everyone does not speak at once. The nature of the session needs to be decided well in advance so that the intended outcomes are realised.

The TLC requires collaboration at nearly all levels which in turn requires mainly synchronous technologies. Internet bandwidth is still the major stumbling block for less costly, effective oral/visual/graphical collaboration in real time. Textual collaboration is useable but has many discourse problems that need to be addressed. With an ever expanding range of technologies, cost effective real time collaboration will be within reach.

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The Integrator: A Tool for Teaching Strategy Acquisition in Scientific Inquiry

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Abstract: The "Integrator" is a part of BioBLAST, a CD-ROM course supplement package integrating concepts of biology and systems design as applied to a high school biology class. Students are presented with an authentic task: to design and manage a controlled ecological system that will sustain life for six astronauts on the lunar surface for a period of three years. Students participate in (1) basic laboratory experimentation, (2) using advanced media for researching background, and (3) formulating questions and carrying out investigations to reach answer(s). The very richness of the activities requires that students carry out – at critical points in the learning cycle – exercises that both consolidate gains from the hands-on activities and mediate the transition of data analysis to concept formulation in the learner. The "Integrator" is a simulation-driven "cognition enhancer" that mediates this all-important step in sound scientific reasoning.

1 Background

The BioBLAST Project (sponsored by NASA and developed at the *Classroom of the Future*, Wheeling Jesuit University) consists of educational software (simulations, microworlds, and interactive multimedia) based on NASA's Advanced Life Support (ALS) research being carried out at several NASA Centers. Sustaining humans in colonies beyond earth's environment requires a balance among components and systems. Focal points of research include: (1) plant production, (2) human requirements, and (3) resource recovery. BioBLAST consists of a six-week curriculum supplement -- featuring scientific investigation, laboratory data collection, and creative problem solving -- built on the scenario of designing a balanced, closed biosphere to support a crew of six living on the lunar surface. Virtual Reality (VR) multimedia increases motivation by presenting a high-fidelity walk-through of the lunar environment. Additionally, a variety of simulation-driven enrichment environments provide opportunities for students to extend the empirical activities of the lab and background knowledge gained in the classroom to the challenging final exercise of creating and managing a biosphere.

2 The Integrator: Teaching Strategy Acquisition through Guided Simulations

The "Integrator" is a cognitive tool that helps students make the important transitions between collecting data, drawing conclusions, and recognizing and applying concepts. This "cognitive tool" puts the student-team in the role of a systems specialist/control engineer who monitors a functioning ALS environment. As an inquiry tool, its "metaphor" is one of systems operations and trouble-shooting. The student team monitors a control panel showing the major "living" elements in the habitat and current status (or balance) of common resources (water, carbon dioxide, biomass, grain, oxygen, and liquid nutrients). A "library" of authentic problems/scenarios present alerts and alarms (system imbalances and prognoses) for the students to work with, appropriately selected to match the activity strand leading up to the session with the "Integrator." From the initial fault report, the students move through structured workspaces that mediate expert behavior patterns for troubleshooting and for evaluating, applying, and adapting a repair that brings the system back in balance.

The "Integrator" uses a hybrid approach for interactive instruction. Part of the guidance comes from that adaptive tutoring that works with the underlying simulation engine and part comes from the powers of reification (or representing complex mental processes as manipulable objects on the computer screen). Four structured workspaces in this tool (1) accommodate deficiencies and thereby reduce frustration for the students, (2) enrich the environment and thereby sustain motivation, and (3) explicitly model strategic intellectual processes and thereby provide the scaffolding that allows the fledgling student to attempt increasingly more challenging levels of participation.

- *Workspace One: List Probable Causes* -- Students complete a statement of cause and effect: "The <specific condition in the alert> exists when . . ." . In order to list all possible causes, the students select from pull-down menus an agent (crew, plant, microbes, etc.), a resource (H_2O, CO_2, etc), a role (consumption or production), and a direction (increases or decreases). This manipulation results in a research agenda – a set of possible causes for the reported condition. The workspace encourages systemic thinking and reinforces the ideas of "dependent" and "independent" variables in a cause/effect statement.

- *Workspace Two: Investigate and Examine Evidence* -- This second workspace helps the students to examine sequentially the potential causes by analyzing evidence from selected attributes for the crew, plants, and microbial elements of the system. In essence, the students perform observations and collect data from which they infer errors. Elements operating out of a defined max/min range can then be flagged. Visualization (thinking frames) and inquiry tools in the workspace help students to see relationships while analyzing data and to draw inferences about the source(s) of the imbalance.

- *Workspace Three: Select "Best" Solutions* – Having empirically proven the cause(s) for the imbalance, the students now construct a repair plan. Once again, pull down menus offer a constrained set of options, allowing students to construct a sentence that indicates a change in the system (e.g., "Decrease grain intake."). Since this is a dynamic, multi-dimensional system, several repairs are possible. Thus, students evaluate each possible course of action in terms of a two-dimensional matrix: high cost/low cost and high gain/low gain. Placing each course of action within one of the four cells helps students to judge actions within a larger frame of reference.

- *Workspace Four: Apply Solution and Adapt* -- In this workspace, the students apply their repairs in the sense that they set conditions, run the simulation, and observe the changes over a selected period of time. Visualization and inquiry tools demonstrate effects in numeric, verbal, and graphic formats. This workspace introduces the concept of "duration" to the problem. Because of the complexity of the ecosystem, some changes will take effect too late to save the elements at-risk in the environment; others will work initially, but over time create side-effects that precipitate yet another (perhaps more dangerous) imbalance. This workspace encourages very sophisticated thinking in that it fosters an awareness of multivariate processes occurring (and perhaps reversing) over an expanse of time.

The Virtual Learning Center: Distance Education on the Web

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Abstract: This paper describes a demonstration version of a Virtual Learning Center developed at Galaxy Scientific. The intent of this paper is to illustrate possibilities of training over the World Wide Web through a virtual campus. Advantages to taking such an approach will be highlighted, as well as, issues that one must consider when implementing such a facility (See CD-ROM version of paper for discussion of advantages and issues). During the conference presentation the Virtual Learning Center will be demonstrated.

Introduction

With the constant pressure of down-sizing, corporations and the military find themselves in positions of having to train their personnel to perform broader ranges of tasks. Personnel are expected to be more skilled in more areas while fewer dollars are available to meet these training needs. Distance Education is enjoying a revitalization of interest among corporate and military leaders, because they recognize the potential benefits as a low cost solution to their training needs. Distance education is a pedagogical approach where people engage in educational activities without having to be at the site where the instruction is occurring. Instruction, resources and students can be distributed across many different locations, and are usually connected together by technologies, such as computer networks, satellite dishes and telephone lines. The vision for the distance education development group at Galaxy Scientific (Galaxy), is to capitalize on the technical capabilities of the World Wide Web (WWW) to create a Virtual Learning Center (VLC) for continuing education of professionals.

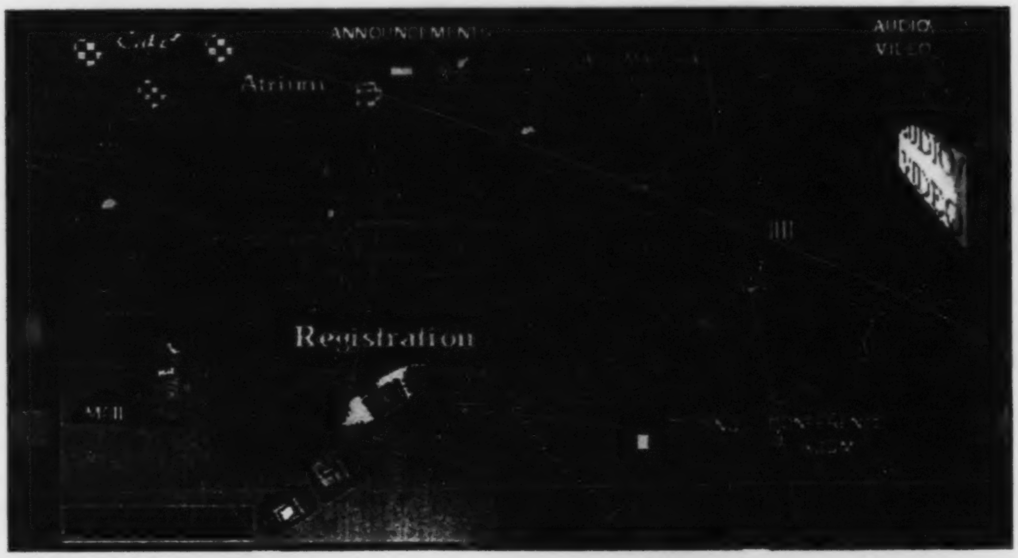

Figure 1: Distance Education on the Web. You may browse a demonstration version of Galaxy's Virtual Learning Center at http://galaxyatl.com/VLC/campus.html.

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The Virtual Learning Center Concept

Upon entry to the Virtual Learning Center, students find themselves viewing a school campus (Figure 1). The campus is divided into four conceptual categories of activities: administration, classes, resources and recreation.

If individuals want to participate in a class they first go to the registration area to sign up for the class or see what classes are being offered. When they register for a class they are placed on a class mailing list where they can send and receive mail to and from their instructor or other class participants. If the class uses video or audio, the student is instructed to go to the audio/visual room in the resources area. This is where students can check out the software and download a list of the hardware they will need to participate in the class. Instructions for implementing these programs are provided in this room, as well as a hot-line to address implementation difficulties or general technical questions. The type and sophistication of the equipment will change with the type of activity that is planned for the class. For instance, a lecture may require real time audio and a presentation "white board" that supports writing annotations on photographs or graphics. A lab may require two-way video between students and instructors.

Scheduled classes occur in the classroom area. In the event a student misses a class, the student can make up the class by visiting the class archives where he or she may check out the appropriate session. To download curricular materials or journal articles or jump to other reference sites, students visit the class materials checkout or references in the resource area. To study and take tests, students visit the testing area.

Recreation is where more informal interactions may be found. The cafe is a meeting place for interest groups to gather and chat about various issues. Announcements for new classes and other community activities are posted on bulletin boards in the announcement room. The game room is a place where people can experiment with role playing through MOOs and MUDs or other simulated environments related to their area of study. Finally the atrium is a place where students can deposit their finished products for others to appreciate. These products could be generated either through a formal class or spawned informally at lunch or in the game room.

In the above scenario, static and dynamic information are seemlessly integrated. At the library, for instance, students read and download articles. At a lecture or conference, where dynamic interaction is desired, two-way audio and video technologies may become the norm. The more general term for this type of facility is computer-mediated communication. Computer-mediated communication is generally divided into three areas: conferencing, informatics, and computer assisted instruction [Collins, Berge; 1995]. The VLC demo developed at Galaxy supports facilities in each of these areas. In the realm of conferencing, such facilities as real-time lectures using a radio talk show style of delivery, bulletin boards for announcements, and interactive chat rooms for class discussions and student-to-student collaboration is available. In the area of informatics, the VLC provides direct mailing of class materials to students through a MailDoc facility. Links to information sites, archiving of class lectures and discussion sessions, and posting of finished projects can be read, played or downloaded through reference and audio/visual pages. These facilities will contribute not only to instruction, but also to the analysis of that instruction for research and evaluation purposes. Computer assisted instruction currently includes on-line testing. In a more experimental realm, the introduction of role-playing and problem-solving activities through on-line ITS, simulation labs or gaming facilities is possible. A Virtual Learning Center approach to Distance Education has huge potential for training. There are many design and implementation issues that need to be address to insure success; however, given the natural modular structure of the VLC, many interesting solutions to distance education across the internet can be accomplished today.

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Acknowledgements

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APOLLO 2000

An Internet-based Interactive, Multimedia, Multiplayer, Virtual Reality Program Applied to Science/Humanities Education

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Recent advances in communications, networking, and computer technology have delivered capabilities to today's classroom computers that overwhelm what was considered possible only a few years ago. Advances in desktop virtual reality, real time rendering, and worldwide Internet linked computers have created an explosion of new market opportunities. It is no wonder that today's students spend so much time on the computer. Multi-player network games, which execute in real-time and contain virtual worlds, offer tremendous stimulation and entertainment for the student. These games create environments where students can challenge the computer as well as other students in increasingly realistic scenarios.

With the advent of the Internet coupled with the recent explosion in desktop interactive visualization capabilities, the ways in which information is transmitted, and the ways in which people interact, and receive information, are also changing. These new modes of processing information need to be accounted for in the educational process to better prepare students for the technological challenges outside the classroom, and to more effectively educate students inside the classroom.

To this end, Mission Research Corporation's DzignLight Studios (MRC), in conjunction with the Space Training And Research Center (STAR) of the California Spaceport Authority at Vandenberg Air Force Base, is developing a Multimedia Interactive Animated Computer Training (MIACT) program under the project name "Apollo 2000".

MIACT is a learning device for students that consists of stand-alone educational modules that combine mathematics and science education with an interactive multimedia environment. The platform of MIACT is a space mission. The primary components are spacecrafts and mission control centers on earth. A conceptual diagram of MIACT is shown in Figure 1.

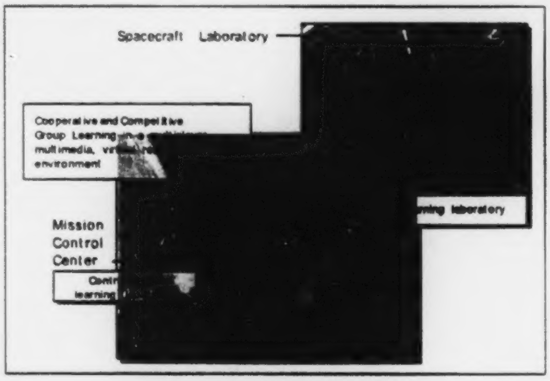
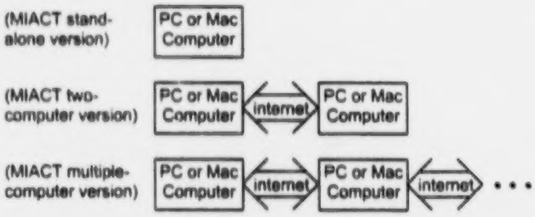

Spacecraft Laboratory
Cooperative and Competitive
Group Learning
multimedia, vi
environment
ning laboratory
Mission
Control
Center
Cont
learning

Figure 1 MIACT Conceptual Diagram

When complete, students in different classes, or at different schools, will be able to run a spacecraft component or a mission control center component. MIACT is being designed to run on one, two, or multiple computers. An interconnect block diagram of MIACT is shown in Figure 2.


(MIACT stand-alone version)
PC or Mac Computer
(MIACT two-computer version)
PC or Mac Computer
internet
PC or Mac Computer
(MIACT multiple-computer version)
PC or Mac Computer
internet
PC or Mac Computer
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. . .

Figure 2 MIACT Interconnect Block Diagram

MIACT incorporates today's technology (including the Internet, 3-D animation, virtual reality, and interactive multimedia) within a real-world mathematics and science learning environment. The modules will teach varying disciplines, including mathematics, physics, chemistry, etc. A particular module can emphasize one discipline, or it can be multi-disciplinary. The modules can be used as a supplement to course lectures, as an assignment, or to teach a laboratory sequence.

The primary components in MIACT are space-crafts and mission control centers on earth. Students in different classes, or at different schools, run a spacecraft component or a mission control center component. Students working on a particular component interact to establish priorities and appropriate courses of action. This requires individual and joint research and problem solving of scientific and mathematical tasks. Students decide who will perform designated tasks (e.g., command, guidance, propulsion, defense, personnel, etc.). During the course of a mission, the students in a component must work together, and interact with the other components run by different groups of students.

To successfully complete a mission, the students must carefully plan the stages of the mission, conduct necessary research, and perform calculations before the mission begins. The students are shown aspects of previous successful and unsuccessful missions. This serves to introduce students to the multimedia format of the educational modules and stimulate interest, and motivate them to do the necessary preparations for their mission. The students are then shown a rudimentary simulation of their mission. The students research will involve mathematics, physics, chemistry, biology, astronomy, etc. Students must perform the necessary calculations and preparations for the mission. They must work as a team to develop and understand the different aspects of the mission design phase. They will therefore be performing analyses and tradeoffs.

If their pre-mission plan is in error, problems due to these errors will be experienced during the mission. The students will have the opportunity to learn from these errors and make corrections during the mission. If the pre-mission plan is sound, the plan must be successfully implemented during the course of the mission. This will require timing and coordination between the members of the spacecraft and the mission control center. If the operations (e.g., using a gravitational field to control flight path) are not implemented successfully, then errors will be experienced.

In addition to these deterministic errors, there will be random errors generated by the module. These errors will include failure of spacecraft components, communication interference, meteors, etc. The students will also have the opportunity to learn from these errors and make corrections during the mission.

MIACT will be used for teaching mathematics and science to pre-college students in an environment that stimulates learning based on situational contexts, involving students working individually and collaboratively, in small and large groups, using concrete materials. MIACT will help students to think and reason through the implementation of mathematical and scientific ideas and tools, communicating ideas, and gaining confidence in their abilities. This will help the performance of students in mathematics, science and engineering courses.

Current Prototype Development Effort

A prototype module is under construction, sponsored by the Department of Energy. The primary educational emphasis will be in the area of mathematics and science. The platform will be designed to run from a single computer, and from two computers. The Phase I effort will demonstrate the state-of-the-art in multimedia and PC-based virtual reality technology.

Intranet Learning Environment for Junior High School's Computer Course

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Abstract: We are developing a school-based intranet learning environment for supporting junior high student's learning of computer concepts. We believe that our evolving intranet environment will demonstrate the usability of integrating intranet technology into junior high school campus and will provide a rich environment for studying the rationales, models, and strategies of network-based on-line learning.

Introduction

We believe that Intranet technology is mature enough to let an organization (such as school) build an internal network environment. And we also believe that the independent Computer course for junior high students should have new learning rationales and models. Based upon the opportunities provided by the new Computer course and by the maturing intranet technology, we plan to integrate the intranet technology into the new course to construct an network-based learning environment, an environment students can have different learning experience.

Design and Development

Technology: We use Web server, Mail server, Workgroup server to set up a server cluster. Video server will be added later.
Learning Materials: There is an official computer curriculum guideline for junior high schools. It has twelve chapters with the emphasis on the basic computer concepts, basic computer operations and computer applications [Chiou & Wu 1996]. It is a computer literacy curriculum. We use prototyping approach to develop the material. Based on our experience, we believe that several required principles have to be followed: (1) avoid the unnecessary classification, (2) avoid unnecessary jargons, (3) example first, abstract explanation second, (4) use analogy carefully, (5) always consider average junior high student's reading comprehension ability, (6) provide deep knowledge for some students (layering the computer knowledge and skills), (7) use new and correct information, (8) do not overemphasize the underlying computer theory (phenomenon first, theory second).
Learning Activities: Currently our intranet environment support browsing, emailing, and asynchronous discussion. Synchronous meeting (such as text conference, audio conference, whiteboard) will be added later.
Learning Aids: We plan to develop on-line computer dictionary, on-line private notebook, and on-line public notebook.

Learning Information Management Utilities: Our intranet learning environment will embed login, tracking, teacher, on-line testing, and portfolio utilities.

Human resources: A successful school-based intranet learning environment will be labor-intensive and mind-intensive. During the process of design and development, it is necessary to consider human resource issue deeply and clearly. Technology is only and always a tool for people, it is us the people who makes the intranet work.

Research Issues

Rationale issue: What learning rationales can be used to guide the development of school-based intranet learning environments? Is it possible to have some new learning rationales? For example, we might try to integrate the existing learning rationales, such as constructivism and community of learners, to form an optimal rationale for network-based learning environment [Chiou 1996].

Strategy issue: What learning strategies are appropriate for the on-line intranet learning?

Moderation issue: What is the optimal model for moderating a domain specific intranet learning environment?

Tool issue: What learning tools or aids should be developed to help student's learning?

Further Considerations

School-based intranet learning environments are the foundations for constructing the Internet learning environment (a form of distance learning). And subject-specific intranet learning environments are the foundations for building school-based intranet learning environment. Constructing a high-quality subject-specific intranet learning environment is the first step toward high-quality on-line virtual learning, even an international on-line learning. And opening the school intranet and connecting it to the community network will be a great opportunities for students, parents, family members, schools and communities. Looking through the intranet window, we could see the opportunities for educational services and educational researches.

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Effectiveness of an Intelligently Adaptive CAI Environment with Cognitive Apprenticeship on Self-regulated Learning Skills

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ABSTRACT: A group of cognitive psychologists identifies effective learners as self-regulated learners who are metacognitively, motivationally, and behaviorally active. This study was concerned with how to prepare computerized learning environments to help the ineffective learners become effective self-regulated learners. This study investigated the effects of two different computer-assisted instructional (CAI) environments and the effects of self-awareness of cognitive tempo styles on college students' self-regulated learning (SRL) skills and their academic achievement scores. MANOVA tests revealed that an intelligently adaptive CAI environment was significantly more effective on behavioral SRL skills than a totally learner-controlled CAI environment. This study suggests that educators and instructional designers invest their efforts in developing and utilizing CAI that serves as an intelligent partner to human cognition and that helps learners become self-regulated learners.

Theoretical Framework

Recently developed computer-assisted instruction (CAI) allows learners to have highly individualized interaction with the computerized instruction. Research studies, however, revealed that neither totally program-controlled CAI environments nor totally learner-controlled CAI environments provide high motivation toward the learning processes and high achievement outcomes [Steinberg, 1989]. Therefore, consideration should be given to designing CAI environments with appropriate instructional methods, which more intelligently interact with individual learners and guide them toward acquisition of required knowledge and skills in each step of learning processes.

Current computer authoring system technology enables instructional designers and developers to incorporate special constructivistic instructional methods such as cognitive apprenticeship into CAI environments [Lajoie & Lesgold, 1989]. Researchers and practitioners of the cognitive apprenticeship teaching method suggest that cognitive knowledge and skills can be taught by cognitive coaching strategies and learned better by *learning-through-guided experience* [Collins, Brown, & Newman, 1989]. When learning is completed, learners will increase learning responsibilities and shift expertise from the computerized coaching system. The process of learning responsibility and expertise shift can be observed by the utilization of self-regulated learning (SRL) skills: that is, metacognitively, motivationally, and behaviorally active involvement in their learning processes [Zimmerman, 1994].

Important for educators are the innovations of CAI environments implementing the cognitive apprenticeship method that helps the computerized instruction become more intelligently adaptive to learners. These innovative CAI learning environments may enable learners to learn in constructivistic ways exploring a rich information world, help them develop effective SRL skills and increase ownership of learning process, and lead them toward successful academic performance. This potential effectiveness of implementing the cognitive apprenticeship method in CAI environments has not been found from totally learner controlled CAI environments.

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Research Design

Based on the theoretical framework, a study was conducted to compare the effectiveness of two different CAI environments on college students' acquisition of knowledge and performance in problem-solving situations. Seventy-five college students participated in the study. There were two independent variables: (a) CAI environments with two levels: an intelligently adaptive CAI environment and a totally learner-controlled CAI environment. (b) self-awareness of cognitive tempo styles: reflective or impulsive. There were four dependent variables: (a) self-evaluation levels, (b) self-efficacy levels, (c) self-learning activity levels, and (d) academic achievement scores. The instruments used in this study were (a) an adolescent-adult version of Matching Familiar Figure (MFF) test to rate the participants' cognitive tempo styles as impulsive or reflective [Kagan, 1981], (b) CAI programs, and (c) a computerized test with 15 questions. Among the 75 participants, 32 participants were defined as impulsive and 43 were reflective by the MFF test. Using a stratified random sampling method, participants in each cognitive tempo group were randomly, but proportionally, assigned to one of the two CAI environments. Five hours were provided for the self-paced learning with the CAI.

Results and Discussions

Two-way MANOVA revealed that, in the CAI environments, there was a significant difference in the college students' SRL skills due to the different instructional methods ($p < .0001$). Implementation of the intelligently adaptive coaching strategy of cognitive apprenticeship method was significantly more effective on encouraging the college students to exercise SRL skills than the totally learner-controlled method. The following univariate test on each variable showed that the self-learning activity levels were the most significant contributor to this significance, $F(1, 71) = 38.50$, $p < .0001$. That is, in the CAI environments, the college students who received the intelligently adaptive coaching method were significantly more behaviorally active ($M = 111.39$, $SD = 16.56$) than the college students who were allowed to have a total control over their learning processes ($M = 81.29$, $SD = 24.44$). There was no significant effects of self-awareness of cognitive tempo styles and no significant interactive effects between self-awareness of cognitive tempo styles and the different CAI environments.

The findings of this research study support Clark's long-run argument that computers are merely delivery tools [Clark, 1994]. The factor that influences learning is the instructional method. Effectiveness of CAI, especially in order to enhance learners' responsibilities in learning, depends on the effectiveness of instructional strategies employed in the CAI environment. This study proved that an intelligently adaptive CAI environment could help college students experience cognitive effects with the computer tools. In particular, the CAI environment that incorporated an intelligently adaptive "cognitive coach" encouraged the college students to employ SRL skills that helped them become self-responsible learners. This study suggests that educators and instructional designers invest their efforts in developing and utilizing CAI that serves as an intelligent partner to human cognition and that helps learners become self-regulated learners.

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HYPERCLOCK : A CONCEPT OF A NEW NAVIGATIONAL TOOL BASED ON HYPER-G

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Abstract: Hyper-G is a second-generation hypermedia information system represented by the features including hierarchical structure, separate link database and so on. HyperClock, a new navigational tool, can exploit such features by developing a flexible and uniform user interface, upon which some information and relationship visualization techniques are developed. Using HyperClock can improve the performance of some hypermedia application issues such as navigation by integrating DAG structure, Local Map and History Map into one interface, and the "getting lost in hyperspace" problem can be solved in a new way.

1. HYPER-G AND HARMONY

Instead of a detailed and in-depth description of Hyper-G and its client Harmony [Maurer 96], only part of their features relevant to the approach in this paper are introduced briefly in following subsections.

1.1. STRUCTURED HYPERMEDIA AND ASSOCIATIVE HYPERLINKS

The Hyper-G Data Model contians structuring element named *Collection*, which is composite object that contains documents or other Collections. This definition leads to the concept of a *Collection Hierarchy*, on which two restrictions are applied :

- Every document or Collection (except for the Root Collection) must be a member of at least one Collection;
- The Collection Hierarchy must be cycle-free, that means, the hierarchy is *Directed Acyclic Graph* (DAG).

Hyper-G stores links in an own database. Links are bidirectional to guarantee the link consistency and are searchable in terms of type and keywords. Documents of any type can be linked with each other.

1.2. NAVIGATIONAL AIDS

Harmony has tightly coupled the Hyper-G's facilities described above to provide the following navigational aids :

- *Collection Browser* : provides intuitive hierarchical navigation through Hyper-G Collection structures;
- *Local Map* : visualization of relationships between object in terms of hyperlink or other attributes;
- *History Browser* : maintains a *history list*, in which each entry is time-stamped.

2. THE CONCEPT OF HYPERCLOCK

2.1. THE INFORMATION VISUALIZATION TECHNIQUE

HyperClock is designed to visualize a DAG structure so that a number of operations on the Hyper-G Collection structure such as navigating, searching can be carried out in an efficient way. From the geometrical point of view, the user interface of HyperClock is a circular plane consisting of a number of sectors where the center maps the current root of DAG and each sector maps a node. In accordance with Collection Hierarchy described in section 1, the concept of so-called *Sector Hierarchy* can be defined in a similiar way. In the case of "1 child

- to - n parents", the "child" is virtually duplicated n times at first, and then each one is mapped to the Subsector of its "parent". Due to the geometrical nature of the circular plane used by HyperClock interface, Sector Hierarchy is defined in a "circle" way :

- *(Sub)Sector* : the same as mathmatical definition. It can be thought of (sub)directory of file system;
- *Circle* : connects all the nodes with the same height in DAG and limits the sectors accordingly;
- *Center* : the root of the current Collection structure of DAG.

In addition to the basic components of HyperClock interface described above, just like pointers of a clock, the other components should also be defined to make HyperClock work :

- *Sector label* : identifies a particular document or Collection;
- *Flag* : marks the location of a particular document or Collection and can be assigned with some value;
- *Dot* : a point located along with the outmost Circle that represents a particular document or Collection. Dots are displayed only if relationships among documents or Collections should be visualized.

2.2. THE RELATIONSHIP VISUALIZATION TECHNIQUES

Based to the information visualization technique used in the HyperClock interface, the relationships among documents or Collections can be represented in various ways to accommodate different needs in some hypermedia application issues such as navigation, and the relationship visualization techniques described bellow can be applied in any combination when needed.

a) Simple connection : segments between related documents or Collections represented by Dots are drawn regardless of direction and other features of the relationship to get an intuitive description.
b) Central connection : in the case of "m - to - 1 - to - n" relationships, the one Dot is placed at the center, all m segments connecting Dots and the center are drawn in one color, all n segments in another color.
c) Inside connection : assum that the relationship between Dots d1 and d2 should be displayed, the visualization carries out in three steps, (1) a value "d-r" along with the radius is caculated automatically according to the amount of relationships to be visualized; (2) segements along with the radius toward the center of length of "d-r" are drawn from d1 and d2 , ending at d11 and d22, respectively; (3) drawing the arc connecting d11 and d22 along with the circle. If the relationship is directed, color can be used to differentiate the incoming "d-r"-segment from the outgoing one.
d) Outside connection : same as c) except that segments along with the radius are drawn away from the center.

3. THE NEW NAVIGATION PARADIGM

3.1. "CIRCLE" INSTEAD OF "LINE"

Different from using "Line"-style interfaces, users are always presented with a sense of global context of certain Colloection with HyperClock. Furthermore, a set of functions are supported in a uniform way regardless of the location in the DAG structure. Relationships among objects in the database can be visualized efficiently in different way to meet different needs.

3.2. "MAP" INSTEAD OF "LIST"

The advantage of "Map" over "List" is that user can jump to some location directly without referring to the "List". While the *History List* can not always provide a clear guide, a *History Map* might help the user decide where to go to. By applying the HyperClock to search issue, the search result is mapped onto HyperClock interface directly to provide a so-called *Result Map*, with which the user can immediately select some collections to refine his search.

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LINES: Learning and Information Support Networks in Europe for SOCRATES

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Abstract: LINES (Learning and Information support Networks in Europe for SOCRATES) is a World Wide Web system to support student and staff exchange throughout Europe. LINES is being developed by a transnational partnership representing the UK, Sweden, Belgium, France, Denmark and Greece and provides facilities to support the whole life cycle of transnational exchange from planning and setting up the exchange, allocating funding, monitoring student achievement to the provision of statistical analyses for institutional, national and European administators. The system supports the European Credit Transfer System and provides on-line Open and Distance Learning support. LINES has been funded by DGXIII of the European Commission as part of the IVth Framework Telematics Applications Programme.

Introduction

Every year a vast number of higher education staff and students participate in European Commission (EC) funded transnational exchange programmes, e.g. ERASMUS. Under ERASMUS transnational exchange grew exponentially: in 1987/88 there were 300 and in 1995/96 170,000 student exchanges within single or multiple exchange networks known as Inter-University Cooperation Programmes (ICPs) each ICP administered separately by a coordinator closely related to the course. In 1997 ERASMUS becomes part of SOCRATES and multiple ICPs within institutions will be rationalised into a single Institutional Contract to give each institution more administrative control through an officer much less closely related to individual courses. Through SOCRATES the EC is strongly promoting the European Credit Transfer System (ECTS) with the aim of giving full credit for transnational study in the home institution. Within SOCRATES transnational exchange is set to grow to a target population of 4,000 institutions, 500,000 staff and 7,500,000 students and thus the scene is set for a management information system which can support the SOCRATES Institutional Contract. LINES is such a system and aims to enhance the transnational experience by supporting the whole life cycle of transnational staff and student exchange from planning and setting up the exchange, allocating funding, monitoring achievement, to providing institutional, national and European statistics.

LINES: Learning and Information support Networks in Europe for SOCRATES

LINES (Learning and Information support Networks in Europe for Socrates) has a total budget of 1 million ECU from DGXIII under the IVth Framework Telematics Applications Programme (one of the largest and most important EC initiatives the strategic purpose of which is to coordinate European actions in communications technology to provide effective competition to the USA and Japan). Against this evolving and generally supportive background a growing number of individuals are engaged in facilitating exchanges or undergoing the experience at first hand. LINES has its origins in the experiences of partners in the Brussels-based BUSINET organisation of some 80 European business schools. LINES is led by the University of Wales Institute, Cardiff (UK) and Växjo University (Sweden) with three other partners: BUSINET who will organise the system demonstration in about 50 Institutions; Artisan Konsult (Sweden) who are determining user needs; O2 Technology (France) - an object-oriented database manufacturer.

LINES aims to use new but established technologies to dynamically support various client groups: staff attempting to establish exchange agreements with other colleges; students and staff contemplating exchange; tutors and administrators keeping track of exchange students, funding and qualifications through ECTS; national and European coordinators seeking summary data. LINES holistically underpins the SOCRATES Institutional Contract and is a generic system covering most institutional needs that is, wherever possible, able to utilise and integrate existing independent systems.

Exponential growth of the total number of students and institutions participating in ERASMUS has brought a concomitant increase in the difficulties of obtaining relevant course information on which to base decisions about appropriate exchanges, e.g. inter-institutional module equivalences - is 'Introduction to Database' in University of Wales Institute, Cardiff equivalent to the same level module 'Database Structure' at Växjo University and would students be able to equate the curricular experience whilst enhancing their cultural experience? ECTS provides a format for making curricula more transparent and is strongly promoted by the EC for this reason. LINES is based on ECTS to enable inter-institutional mapping of modules and programmes.

Maintaining up-to-date documentation in a pan-European context is problematic. The LINES object-oriented database uses dynamic data acquisition techniques to deliver current information on potential exchanges. LINES uses a federated/distributed database in which each institution has responsibility for the maintenance of its own data. LINES is a dynamic information resource with course and module details as well as information on the exchange institute, its geographic region and culture to help preparation for exchange.

LINES also lays the foundation for integrating Open and Distance Learning (ODL) to support ECTS. One of the common difficulties encountered in exchanges is the dichotomy between the potential benefits for the student and the results of mismatch in study programmes that lead to study deficits on return home. On-line ODL is the favoured solution to overcoming curricula mismatches, LINES lays the foundations for a very large ODL network across Europe. Linked to the module database four ODL packages have been prepared to demonstrate the framework although LINES has concentrated not on ODL production but on collaborative ODL development and delivery issues in a pan-European context.

An α-version of the LINES system has been produced for evaluation from January 1997 at four sites (UK, Sweden, Denmark and Greece) the results of which will inform the development of a β-version for July 1997. The β-version will be used to administer SOCRATES exchanges between July and December 1997 at 15 sites that have been selected for their competence in developing computer systems. The project is scheduled to expand to around 50 sites during the demonstration phase in 1998.

Conclusion

Against a background of projected and rapid increases in the number of staff and student transnational exchanges and their mode of administration, LINES is a powerful administrative tool to support participating administrators, academics and students within SOCRATES. Functionally LINES uses dynamic data acquisition techniques to provide a single coherent networked system which enables tracking of individual mobility and supports: student registration; records of achievement; modular support; study programmes; distance and open learning; financial tracking; statistical reporting for exchange administrators at a national and European level. LINES has in-built generic features that facilitate the support of a wide range of functions within the overall umbrella of lifelong learning and could support other credit-based exchange programmes.

Acknowledgments

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The Power of Animation in Visualizing Mathematics

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Abstract: The impact of computer algebra systems (CAS) combined with powerful computers on the mathematics curriculum are enormous. The mathematics instructors are gradually changing their teaching techniques because of these technologies. One can use a CAS such as *Mathematica* to create animations to successfully teach certain mathematical topics which require visualization. In this paper, we will show how to use *Mathematica* to create animations of classical Greek curves such as cycloid, astroid, cardioid and deltoid.

Introduction

Using a CAS such as *Mathematica*, mathematics instructors can create animations to effectively deliver their message. There is some amount of research supporting the effectiveness of animations in computer based instruction. For example, there are studies comparing learning conditions of text only, text and graphics, and, text and animations [Baek & Layne 1988]. It shows that the adults in the study were able to score higher in the animation condition than either text or graphics. For other encouraging studies supporting the use of animation, the reader is urged to refer to [Mayton, 1991].

In this paper, we will show how to use *Mathematica* to create several mathematical animations to understand the classical Greek curves such as, cycloid and the astroid. For the interested reader, some good references on *Mathematica* are [Wagon, 1991] and [Wolfram, 1991]. What we have used is *Mathematica* version 2.0 on a Power Macintosh platform running at a clock speed of 90 MHz.

The Cycloid and the Astroid

The cycloid and astroid belong to a large family of curves known as the classical Greek curves. Other such include cardioid, cissoid, conchoid, deltoid, nephroid, strophoid and trochoid. Most of these curves can be generated by considering the loci of suitable geometric objects. Therefore, one of the best ways to visualize some of these classical Greek curves is by making animations. In the treatment below, we will only consider the cycloid and astroids. For further details on these and other classical Greek curves, the reader may refer to [Burton 1991], [Eves 1992] and [Yates 1952].

(a) The Cycloid

Consider a circle rolling along a straight line without slipping. Then the path of a fixed point on the circumference of the circle is called a cycloid. For example, a mud patch on the edge of a rolling tire traces a cycloid. One can effectively use a *Mathematica* animation to visualize the shape of this curve, as given by the following program.

Program 1

```
a = 1;
Do [ Show [ Graphics [ { Line [ { { - a  - 1, 0 }, { 4a*Pi + 1, 0 } } ], { Thickness[ 1/180 ],
Line [ { { a*t, a }, { a*t - a*Sin[ t ], a - a*Cos[ t ] } } ] }, { RGBColor [ 1, 0, 0 ], Thickness [ 1 / 250 ],
Circle [ { a*t, a }, a ] }, Table [ { RGBColor [ 0, 0, 1 ], PointSize [ 1 / 160 ], Point [ { a*u - a*Sin[ u ],
a - a*Cos [ u ] } ] }, { u, 0, t, 4Pi / 40 } ] } ], PlotRange -> { { - a - 1, 4a*Pi }, { - 0.2, 2a + 1 } },
AspectRatio -> Automatic ], { t, 0, 4Pi, 4Pi / 40 } ]
```

When the above animation is run, one can notice a circle rolling along a straight line. The animation creates footprints of a fixed point on the circumference of the circle. In this way the beginner can easily visualize how the cycloids are generated. Some frames of the animation are given below in [Fig. 1].

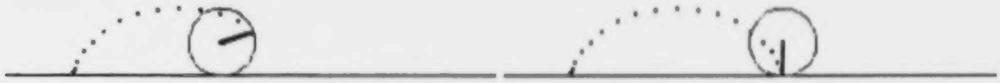

Figure 1: An animation of a cycloid

It must be noted that an arbitrary point (x, y) on the cycloid can be parametrized by the equations $x = a(t - sin\, t)$ and $y = a(1 - cos\, t)$. Here, a represents the radius of the rolling circle, while t is a real parameter. One can use this parametrization to verify several mathematical properties of the cycloid. The cycloid is in fact, quite rich in history. Famous mathematicians such as Galileo (1599), and Roberval (1634), and architects such as Sir Christopher Wren (1658) have discovered several mathematical properties of the cycloid ([Yates 1952]). The cycloid also provides the solution to the famous Brachistochrone problem, first proposed by Jean Bernoulli in 1696 ([Burton 1991], [Eves 1992] and [Yates 1952]). Because of its elegant properties, and the controversies it has caused among eminent mathematicians, sometimes the cycloid has been called the Helen of Geometry.

(b) The Astroid

This is another classical Greek curve that can be generated by methods similar to that of a cycloid. Consider a small circle, rolling without slipping inside of another bigger circle with radius four times as large. Then the path of a fixed point on the circumference of the small circle is called an astroid. Unlike the cycloid, the astroid has four cusps. For this reason, sometimes it is called the tetracuspid. The following *Mathematica* programs creates an animation to generate the astroid.

Program 2

```
Do [ Show [ Graphics [ { Circle [ { 0, 0 }, 1 ], Circle [ {3 / 4 Sin [ t ], - 3 / 4 Cos [ t ] }, 1 / 4 ],
    { RGBColor [ 1, 0, 0 ], PointSize [ 1 / 50 ], Table [ Point [ { ( 3Sin [ s ] - Sin [ 3s ] ) / 4,
    - ( 3 Cos [ s ] + Cos [ 3 s ] ) / 4 } ], { s, 0, t, 2Pi / 40 } ] } } ], AspectRatio -> Automatic ],
    { t, 0, 2Pi, 2Pi / 40 } ]
```

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Computerized African Language Learning (CALL)
Interactive, adaptive, dynamically expandable and using multimedia

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Abstract

The paper reports on a computer assisted language learning title to teach an introductory course in Xhosa, a native African language spoken by most of the black citizens of the Eastern Cape Province of South Africa. The course is aimed at non-Xhosa speakers. The course interact with the user, adapts to some of his preferences and displays Xhosa sentences/phrases and allows the user to listen to its pronunciation. An audit trail is kept of all the details of the user's interactions and performance. The system can be expanded by changing the database consisting of the words, phrases and wave files.

1. Introduction

Xhosa is a native African language spoken by about 10 million black South Africans, predominantly from the Eastern Cape Province of South Africa. The University of Port Elizabeth (UPE) is the largest of the five Universities serving this region. Xhosa is one of the eleven official languages in the new South Africa, and one of the three languages extensively used in the Eastern Cape, the others being English and Afrikaans. The latter two languages are mainly spoken by people of European descent who has no or very little knowledge of the Xhosa language and culture.

In order to improve relations at all levels of society and business, it is important that as many as possible non-Xhosa speaking people, in the Eastern Cape at least, obtain a reasonable reading and understanding proficiency of Xhosa. This need motivated the research for and development of this multimedia-based introductory Xhosa language course.

In the design the ideas expressed by Eve Wilson [Wilson 94] has been very helpful. Since it is considered that interaction with a foreign language in text form represents input from which learners can discover grammatical regularities more easily than in its spoken form [Carrol 86], interaction is mainly through typed text, but learners do have the choice of listening to the Xhosa pronunciation. The course was developed using the QUEST authoring system supplemented with a number of DLL's written by one of the authors.

This course is aimed at non-Xhosa speakers with a good reading proficiency in and comprehension of English, and no or very little knowledge of the Xhosa language. Furthermore, little knowledge of computers is required. At UPE this CALL course will also be used to supplement the conventional course in providing unlimited drill and practice.

Objectives :

To facilitate the learning of Xhosa in order to read, understand and write it, with less emphasis on speaking the language; to allow for updating the learning material without recompiling the title; to dynamically adapt to the preferences and the level of the student.

2 Structure of the Course

The course structure is based on an introductory Xhosa course which has been offered by the Department of African Languages at UPE. This course was previously implemented as a CALL by Dr R M J Britz of this Department, but it had severe limitations [Britz 88]. The problems experienced however, were valuable in the design and implementation of the new multimedia-based course. It was, for example, experienced that learners had extreme difficulty with the complex grammar, spelling and the pronunciation of the Xhosa language.

After the login/registration screens, the learner is presented with a content page displaying all twenty units of the course. Unit one deals with the infinitive of the verb. Units 2 to 9 covers the different classes of nouns. Unit 10 is a revision test/tutorial on units 1 to 9. Units 11 to 19 covers with increasing complexity the construction of sentences and deals with the declinations and inflections of verbs and nouns. Unit 20 is a revision test/tutorial on units 11 to 19.

In general a unit is structured in pages (frames) as follows:

- Examples are given in text, followed by a few questions directing the student to discover the specific knowledge.
- Feedback on the answers of the questions is given followed by a summary of the theory/knowledge and any exceptions, if applicable.
- A number of questions is given relating to the specific knowledge followed by feedback.
- Browsing randomly through the examples pertaining to the unit.
- A test on the unit which is corrected with feedback. Once the test is completed the student can request his statistics on the test, redo the unit/test or if the test was passed, continue with the next unit.

3 Learner Model

When a learner enrolls for the course he chooses a usercode and password, and then supplies his full name, the name he is called by, age, gender, level of education, English reading proficiency, knowledge of Xhosa, interest in the subject and computer familiarity. The Last unit number passed and for each test the number of attempts, the highest and average score, learner's preferences for voice and automatic speech is updated dynamically.

For each learner an *audit trail* consisting of entry date and time stamp, number of voice clippings listened to for each frame, score, questions and answers for each test, changes in the learner's preferences for voice and automatic speech, details on each interaction with a scenario, details of each consultation of the dictionary are stored.

Apart from the test on each unit, the two revision tests mainly serves to assess the learner. The audit trail contains the detailed information on the scores of all the tests and an analysis of these will lead to an improved assessment in future. A more complex learner model on the lines of the ideas reported by Shute [Shute 94], is being designed, which should improve the adaptability of the system.

4 Didactic Model

Since most users will have little knowledge of the language, it is important to use didactic models which will aid the learning process. Throughout the course, the Xhosa phrases/sentences and its English meanings are displayed, and the learner may repeatedly listen to the pronunciation of the Xhosa displayed by merely clicking on it.

The learner is also guided through the units in that he must pass the test in each unit in order to continue with the next. Although the learner can see all the units in the contents page, he can only access the units already passed and the next one. Once a unit has been passed he can repeat any frame of the unit through a little unit index for revision and drill purposes. Since examples, drill and test questions are randomly selected, repetition of frames is not boring.

The approach thus far described, is mainly instructivistic. The independent browsing through the scenarios and dictionary represent a constructivist approach.

5 System Evaluation

The system forces the learner to evaluate the system at regular intervals after successfully completing predefined sections of the course. The learner is automatically taken to a specific evaluation page for the section where he must answer multiple choice evaluation questions before he can continue! Furthermore, users are invited from the contents page to complete an evaluation form represented as a page consisting of a number of multiple choice questions [Agnew et al. 96] [Dutt et al. 95]. Answers to the evaluation questionnaires are also recorded in the audit trail.

The course supervisor is able to register students, set parameters, print various reports and change some of a student's data. Sophisticated methods and programs will have to be developed to analyze the audit trails statistically in order to evaluate each component of the course, to establish which learning material is difficult for the learners and to determine areas where possible remedial units may be required.

6 Scenarios and Dictionary

Scenarios evoke curiosity and stimulate learning [Lepper 1993]. Therefore, a number of scenarios are available depicting some everyday scene, e.g. a typical kitchen where a mother is busy preparing a meal, also showing children and pets. By clicking on any object a typical Xhosa sentence or phrase will appear and the learner hears the associated speech. It could also trigger a small animation to depict some action. This approach will allow the learner to discover names of objects and sentences in context of the scene.

In view of the importance of on-line dictionaries and glossaries ([Aust et al. 93] and [Roby 94]), an on-line bilingual dictionary is in progress. It will contain all words used in the course and with each word the typical expressions and phrases using the word, meanings and possible synonyms. The learner must also be able to listen to these Xhosa phrases/sentences. In working through the units he must be able to select a word and link to its entry in the dictionary and/or have the option to browse the dictionary to see 'adjacent' or closely related words.

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'Techknowledgy' Transfer and CMC in Higher Education in Australia

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Abstract:- This paper reports on the use of computer mediated communication (CMC) in classes for fourth year and masters students at the University of Wollongong in Australia. Each year the CMC component of the subject has been orchestrated in a different fashion to enable the role of the moderator to be examined. Importantly, the appropriated notion of 'technology transfer', is examined in relation to the CMC. Students benefit from the opportunity to interact with each other, the educator and the guests (experts) invited to participate in the 'event'. Preparation is critical to the optimal use of CMC in higher education, so transfer of knowledge about the operational aspects of the software as well as the affective aspects of CMC has to be considered before the CMC is conducted. The approach recommended mirrors the literature on technology transfer that calls for greater dissemination of the knowledge 'behind' and embedded within the technology and its use.

Technology transfer

Technology transfer is a concept that is often found in the literature relating to the implementation of 'high-technology' by under-developed countries or it may relate to the uptake of new technology by an organisation. It has been argued that the provision of hardware and/or software without the background knowledge that led to its development and which is arguably crucial to its maintenance is only going part of the way to 'transfer' the technology to the recipient. The following excerpt [DIST, 1994] is germane to the issue

> Technical progress cannot be exclusively embodied in capital good, because it consists of a part 'embodied' in people, institutions and societies. Hence as Arrow (1962) points out, 'learning by doing or using' is an important factor in the uptake of new technology.
>
> Technology uptake refers to far more than simple introduction of new machinery onto the factory floor or into the office and much more than the simple transfer of technical information. Of greater importance is the transfer of know-how (that is, accumulated learning-by-doing skills) which is extremely firm-specific in nature. This is because internal reorganisation of both production and management processes, and upgrading of skills, may be essential to capturing economic value from investment in new technology (OECD 1988). [DIST, 1994. p.23]

In this paper the concept of technology transfer is appropriated and applied to the use of computer mediated communication (CMC) to see if the greater provision of information about the non-technical (social) aspects of computer mediated conferences can help to deliver greater benefits to students. The learning by doing, referred to by Arrow, may be enhanced if the students, as 'receivers' of the new technology, have been well prepared. Through increased understanding, the students' own, 'internal reorganisation' may well be promoted in the form of improved learning - a change to the cognitive strucutres? The conferences in question have been run during 1995 and 1996 and form an integral part of the students' studies from both content and experiential perspective.

Computer Mediated Communication/Conference (CMC)

From experience with CMC the author has formulated the notion that the use of this technology in education requires detailed preparation that attends to both the technical aspects, such as the use of software and hardware, as well as to the social components. The neologism 'techknowledgy' is therefore introduced to emphasise the knowledge component of technology whether it be codified or tacit in nature. Within a computer mediated conference students have a need to use email and screen editor software and, in the cases under examination, they also needed to learn how to use a 'listserver' i.e. the conference software. In order to research the notion of 'techknowledgy' transfer the author has incorporated conferences into his subjects and has experimented with different emphases over time.

The literature on CMC has become expansive and contains a number of salient lessons for educators wishing to use CMC in higher education. Now recognised as a medium in its own right, CMC cannot be taken for granted when it is used in education. Students need to be aware of the medium to use it effectively and so providing them with information (training) about the 'mechanical' aspects of accessing a conference and making contributions is only one part of the educators' task. In this author's opinion it is also necessary to bring lessons from the literature to the students so that they can be forewarned about the CMC and how others have felt during their own experience. To this end an appropriation of the notion of technology transfer referred to above, is advocated, with the intention of advising the students about the volume of mail they will receive and the effect that that volume might have on them; they are also told about the use of idiomatic language and the need for it to be accompanied with some form of 'decoding' so that other participants can distill their meaning; I suggest to them that their own learning will be opimised if they become involved in threads of discussion, rather than remain as 'lurkers'; comment on the style of the medium and its impact on dialogue, is provided, in particular the tendency for the text responses to become truncated, terse and unlike other forms of expression and media used in discourse; and I advise the students about the issues of stereotyping other contributors. These are among the topics that I believe need to be addressed in advance of the formal CMC component of a subject of study if the environment of CMC is to become 'familiar' and the learning maximised. Interestingly, not all of these relate to the actual content, nor its meaning, for they go outside the dialogue to the contextual arena. It is my contention that the students will gain most from the experience if they are able to immerse themselves in the discussions, though not always by dominating the discourse with their contributions. Immersion here refers to their informed observation of the progress of the CMC in terms of both its content and its 'feel'. I am not suggesting, however, that we look for ways to 'can' such a feel for mass production, for the tone and texture of any CMC depends on its participants. The 'feel' of the CMC is nonetheless an area for further examination and the current (ongoing) study is attempting to do so. The CMC literature reports instances of conference goers feeling threatened, marginalised and inadequate and due attention is being paid to these as being some indicators of comfort. The way in which the participants 'relate' to the conference is likely to be a measure of their degree of comfort and so the emphasis has been on collaboration and non-competition.

The Conferences

In both the conferences held to date the students (fourth year and masters levels) have been given instruction in how to use email ('elm'), a screen editor for use on a UNIX system ('jove') and how to subscribe to, and then to use, a listserv ('majordomo'). The 1995 students were given a cursory introduction to the concept of a CMC but no attempt was made to inform them of the various findings in the literature regarding the implications of the use of such a medium. No 'netiquette' was covered nor were anecdotes provided about what other educators and students had found in their own use of CMC. In short the 1995 groups were introduced through a primarily technical training approach. The 1996 students' instruction included all such information and, in addition, some discussion during the CMC was focused on the issues of the 'look and feel' of the conference so that the participants were required to reflect on how they were reacting to the CMC at those times.

In both years a number of guests, academics and professionals, have been invited to the CMC with the purpose of being advisors to, and resources for, the students. The students form groups to research and then compose 'journals' which are the major assessable item in the subject being studied. The journals are broken into 'chapters' which are the responsibility of a single student and which collectively are brought together (as the journal) to answer the groups' question. The students receive a common score for their journals' 'editorial consistency' and they receive an individual score for their own chapter which is a sub-set of the journals' topic.

Threads of discussion in the conferences were related to the students' journals and to the subject which examined

- the 'information society'
- the impact of information and communication technology (IT) on society especially in regard to the skill and knowledge required to be a highly valued member of the work force - a knowledge worker, and
- the manner in which IT could be used to facilitate higher education for the knowledge worker group

Data from the Computer Mediated Conferences

The students in the two CMC conferences, conducted to date have been surveyed for their opinions and observations about the way in which the CMCs have been operated and the way in which they have responded. Their comments have been reported elsewhere [Dean, 1997] and here, due to space constraints, the crucial findings only are presented.

Students were asked to complete summative questionnaires, of the CMC, at the completion of the subject, with due regard for anonymity. The selected data presented here were collated from 73 students' responses received over the two years as follows:-

1995	undergraduates	18 responses with 6 female and 12 males.
1995	postgraduates	24 responses with 7 females and 16 males (1 wasn't indicated).
1996	undergraduates	20 responses with 11 females and 9 males.
1996	postgraduates	11 responses with 3 females and 8 males.

The questionnaires were almost the same for the two years (the 1995 questionnaire had 35 questions rising to 36 in 1996). The majority of the questions were closed and used Likert-type scales with five categories, other questions were open and elicited answers in either numeric or prosaic form. The responses to open questions have been tabulated and categorised subjectively on the basis of their similarities and/or differences. A few questions were nominal and asked for one of the proffered choices to be selected.

Being exploratory studies the author expected that the students would have responded differently over the two years. This they did though not for the reasons that might have been foreseen. There were a number of variables that may have come into play during the CMCs including the participation of different guests and students, different journal topics under study (for 1995 and 1996) and the different amount of pre-exposure to the use and role of CMC in higher education. No attempt was made to control these variables and so caution is warranted in any further extrapolation from the results. Unless otherwise stated all the ratings or scores here were from 5 point Likert-type scales, 1 to 5 with 5 being highest.

In general the students have endorsed the use of CMC in their studies with an overall average of 3.48. However the 1995 group average of 3.64 exceeded that for 1996 at 3.26 indicating that factors other than the introductory preparation were at play.

At 3.81, for the two years, the students view positively the future role of CMC in higher education and they averaged 3.84 in their view of the capacity of CMC to further their knowledge as a part of formal study. With an average of 3.77 they seemed to believe that CMC may also have a part to play in their professional employment and/or development. An important follow-on from this realisation is the finding that, with an average score of 4.36, they have come away from the CMC believing that it will be very advantageous in the event that they are involved in a similar forum again - in other words the learning by doing seems to have had a resoundingly positive outcome. This finding would seem to support the contention that the technology has been 'transferred', in operational terms at least. The students' rating of the difference in their self-assessed knowledge of the CMC environment before (3.33) and after (4.18) the CMC was also an indicator that a good deal of learning had occurred. What is still an unknown, in the sense of this paper, is whether the argument in favour of the detailed exposure of students to the CMC literature as a part of their preparation can be sustained on the basis of the students' evaluation of the CMC. The CMC for 1997 has been restructured within the subject so that the students will have a two week 'trial run' of the CMC software (and the environment) before they launch into the real thing with the invited guests. This will hopefully point more conclusively to the role of such a preparation in 'transferring' the technology to the students.

The research in progress now moves onto the next stage which will see the students given the same full introduction as in 1996 but which will this time be accompanied by changes to the way in which the conference is conducted [1]. The conferences so far have been unmoderated with the author taking a back-seat role in the discussions though he has been active in the operational aspects of the conferences. In 1997 this will change so that the moderator role will be more pronounced. From what the students have had to say in their responses this particular change will be warranted and timely. The extra question included in the 1996 survey asked students what role the moderator should play. The 29 replies centred around 'editor' (11) and 'guide/facilitator' (10) though 1 said there was no need for a moderator and 5 suggested the role be confined to administration. From the many comments received the 'editor' should attend to tasks such as providing summaries and/or commentary;

filtering contributions and providing censorship and providing thread control when the conference has become fragmented. In a similar vogue the 'guide' was to lead topics, encourage participation, facilitate discussion, and provide email and technique training. When the reported 'worst three aspects' of the conferences are examined it is easy to see why the students believe an active moderator is needed - the 'volume of email' rated as the main culprit with 'amount of irrelevant information' coming second and 'time consumption' being the third area for complaint. On the other side of the coin students reported the 'best three features' - led by 'access to the international guests and their expertise', followed by 'access to a wide range of people for ideas' and then 'collaborative group work'. All six would seem to be likely beneficiaries of improved control within the conferences and so the change to the moderator role will be appropriate, timely and relevant to the ongoing research of the notion of 'techknowledgy' transfer.

Another interesting result was the identical score (4.1) from both years in relation to the 'promotion of the collaborative ideals involved in the CMC' which seems to verify the students' beliefs that the CMC experience has merit. It also seems to suggest that the students' experience has not suffered from the differences in provision of information outlined earlier. This needs to be followed in the research especially in terms of the relationship to the 'transfer' notion at issue in this paper.

The students estimation of 'CMC as an integral part of learning in future higher education' scored 3.74 and 3.86 for 1995 and 1996 respectively which is encouraging to this researcher given the amount of time and effort that is spent in organising and conducting such events. Similarly they scored 3.87 and 3.69 for 1995 and 1996 respectively when asked about the 'capacity of CMC conferences to further their knowledge as a part of their professional employment'. This also has a related importance in view of the fact that the students are all likely to become knowledge workers [2] as a result of their studies. Such workers are faced with the challenge of constantly updating their skill and knowledge bases and it may well be that they turn to CMC as a medium to provide such updates. In this sense the CMC has also played a vital role in informing their current skill and knowledge bases which was one of the essential reasons for undertaking the conferences in the first instance.

This paper has introduced the notion of techknowledgy transfer and has related it to the ongoing research of computer mediated conferences in higher education. It has been argued that there are crucial non-technical components to the medium that students should be introduced to in preparation for the advantageous use of this medium as a conduit for learning. The research has not been conclusive and is open ended as to the likely outcomes. However, if technology is seen to be 'disembodied intelligence' then it must have a non-technical manifestation which in the mind of the author is an area in need of further examination. It would also seem that the notion of technology transfer in its more usual place of study would do well to consider the cultural and contextual facets if greater success, than in the past, is to be had. CMC has potentials for assisting learning but like so much of our modern technology there is still much to be understood.

Footnotes

[1] The CMC conferences are run in the first session of our university calendar and last four weeks. Any reader wishing to observe, or participate in, the conferences can contact the author via the email address at the start of this paper. Classes would also be welcome.

[2] Readers are directed to references such as Robert Reich's The Work of Nations and Peter Drucker's Post-Capitalist Society for further information about the knowledge worker in the modern labour force. In brief they are people, usually highly salaried and educated, who contribute to their organisation by virtue of their intellectual capabilities. Adding value to information and creating new knowledge are fundamental to their performance.

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iDEANet - An Exploration of 'Poly-Media':- the Potential of Compressed Video Television in Distance Education.

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Abstract: This paper draws on path breaking experimental work conducted by the author which combines broadcast television with computing, and video and audio conferencing. The paper takes a 'what if' approach to show that this is a low-cost alternative for interactive distance education. The suggested configurations can be replete with high-technology aides or can be streamlined to suit the purpose of the educational endeavour and scaled back, where necessary, to match the existing information and communication infrastructure. The paper will draw on the original 'poly-media' configuration trial and the presentation, which is intended to be interactive and collaborative, will consider further hybrid application of the approach.

In November 1991 the author conducted a trial broadcast that brought together the technologies of television, video and audio conferencing and computing. The idea was to investigate the mix of these technologies to see if, firstly, the experiment would work and then, secondly, to consider the ramifications of success for the application of the approach to distance education. The first element was achieved with the yardstick for success being the decipherable reception of the signal by people in their own homes. Having proven that the technology was technically feasible the task to consider further application in distance education has been ongoing, hampered to this day by a lack of funding, interest and commitment. This paper then is a condensed attempt to re-ignite interest in the confluence of the technologies, used in the experiment, with a view to promoting it as a low-cost alternative for distance education delivery in both developed and developing nations. A fuller treatment can be found in another paper. [Dean 1996]

There are over 760,000,000 television (TV) sets in the world, many of which are used communally to overcome local deficiencies in finance or infrastructure. In more prosperous nations, ownership of TV sets is the norm for individual households with multiple sets often being purchased. One great benefit of TV is that people do not have to travel to be able to receive the transmitted broadcast signal. This is not the case with video conferences which are narrow-cast to the participants at, generally, fixed locations. In countries where video conference technology has been introduced to the delivery of distance education students are required to converge on a common place to be able to take place in the discourse. Similarly audio conferences are narrow-cast as well and so long as students have access to a telephone they can access such activities. Broadcast TV is expensive to produce but video and audio conferences are not, at least not by comparison, but they can hardly accommodate the vast numbers that regularly watch TV (in any transmission format).

The experimental broadcast sought to combine as many of the benefits of the respective technologies as was possible so that the resultant hybrid, which I have dubbed 'CVTV' - (compressed video TV) - would be an affordable alternative to the other available media, which tend to be fixed purpose. To this mix I also added computing technology so that the trial broadcast could simulate a lecture in higher education, with as many learning support devices on show as was possible for the 30 minute, specially approved, broadcast. This overall marriage of technologies I now refer to as a 'poly-media' approach to distance education and it is my hope that the concept once developed to a fuller extent might become known as iDEANet signifying its cognitive and network orientation. However, the naming conventions are secondary to the educative potential of the concept and to its realisation I now return.

CVTV - Trial Broadcast

The trial not only proved that the signal from a video conference studio could be redirected via terrestrial lines to a broadcast TV station but it also showed that the broadcast video conference pictures received in the viewers' homes was of equivalent standard to that received by the second video conference site (which was outside the viewing area). What this indicates is that, for a significantly reduced cost, an educational institution, in league with a broadcaster perhaps, could have an enormous audience for its 'product'. It is true that there would be a limit to the amount of interaction possible. The viewers (students) receive both picture and sound but by using a concurrent audio conference they only have an audio return channel. However, the trial showed that the six selected households in the viewing area could interact with the presenters in both video conference studios as well as with each other, via the same link. Students, as one suggestion, could therefore be 'rostered' over a session of teaching to represent their peers, asking questions and having input, and where feasible a telephone number could also be used to provide out of broadcast contact with the relevant academics or presenters. Again if the technological infrastructure allowed, the students could also be in contact with the studio(s) via (a)synchronous computer technology such as email, or real-time chat (e.g. MOOs or Internet Relay Chat) to have input whilst the broadcast is in progress. However, the permutations are numerous and will of course be subject to the local conditions and constraints. From the presenters point of view CVTV is a 'warts-and-all' approach to the use of the visual media, that is, if the transmission is to be in real-time. An alternative is to move to pre-taped editions with or without the expert in contact for the broadcast, which then allows for the tape recordings to be edited. In any event the signal can be taped in the home, or business, for later study so this variant allows for students to be present for the ephemeral broadcast or to tape it and then 'time-shift' to a time suitable to themselves.

There are too many aspects to this work to do justice to them all here. Suffice to say that if an institution could redirect video conference signals to a willing broadcaster then the cost of delivering the education to a 'mass' audience will be greatly reduced in comparison to the usual broadcast TV product. In the CVTV trial the potential viewing audience was about 500,000 people and the signal was delivered to their homes as a free-to-air broadcast. All up the costs for the trial, including costs of running the transmitter, hiring the necessary telecommunications lines, running the conference sites and so forth would have amounted to a figure under A$1000. That figure would have been much the same had the signal gone to a national broadcaster where the audience would have been, potentially, about 98% of the Australian population! Such economies must have a place in distance education, somewhere in the world, and this paper is an attempt to reach the people or institution(s) that can see the benefit of such a low cost alternative to current methods. I have been careful to keep in mind the level of technological sophistication present in countries around the world so that the ideas presented here can have applicability in widely varying circumstances. It is acknowledged that the solution presented herein requires substantial start up costs to acquire the video conference site(s) and to provide connectivity to a broadcaster. However, at the other end of the spectrum it is possible to utilise all the power and sophistication of the Internet and world wide web in CVTV presentations and to do so in real-time if that is desired. About the only thing that this approach is not suitable for is the presentation of very-high quality images (but then video conference signals are not meant to do so) or large amounts of rapid movement. An educator could however show three-dimensional objects, do free-hand drawing or painting, display computer images, use taped audio or video inputs, and hold a joint conference (as was the case in the trial) with a relevant guest or expert elsewhere in the world - in the latter case students would also have the opportunity to speak to such a person as well.

Broadcast TV in higher education has had a potted history. Many universities continue to use the technology and some are moving into this mode as pressures for places in their institutions increase. However, the relationship between broadcasters and higher education institutions has been uneven, to say the least, and this is in part because of the expectations that exist about the production quality of public broadcasts and broadcasters are very reluctant to hand over quality control to educationists. On the other hand educators have often reported their dissatisfaction with the results of the high cost TV production approach in which they have little control over content and 'flow'. Pedagogical technique seems to be the casualty in many cases and it is significant that pioneers of the use of TV in higher education, such as the Open University in the United Kingdom, have continued to reduce their reliance on this technology as a modality for the delivery of distance education. What is being suggested in this paper is an alternative to the 'slick' production values to which we have become accustomed over the years from watching broadcast TV. I have argued elsewhere [Dean 1996] that the 'expectations' of quality have not been rigourously tested in relation to students of higher education and the low-cost alternative may hold many promises that deserve to be investigated. Already the lower grade images of the video conference, accompanied with good quality audio, have been found to be acceptable to students, in university research, around the world. The CVTV hybrid seeks therefore to take that acceptance into a new arena by marrying the video conference signal with a broadcast capacity to reach larger student audiences.

Since the trial was run, the author has conducted further investigations of the approach outlined here. Not all of that work is able to be released, or published, as yet but is available under commercial, in-confidence, arrangements. The research in progress needs support to reach its full potential and to this end the current paper

solicits contact from interested parties. I hasten to add that this should not be construed as a shameless attempt at money grabbing, for the project, from its initiation, has had the greater good of the public at its core. I firmly believe that the CVTV concept has merit but to date I have had very little success in being the so called 'champion' of the technology in its educational setting and the progress of the project has been an object lesson in innovation theory. Somewhat frustrated, even daunted by the history till now, I have written this paper as yet another attempt to break through and I hope that what has been presented here will be enough to whet the appetite, or pique the interest, of someone who can help to bring this educative potential to fruition.

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Design Issues for Hypermedia Educational Environments: The Case of "ISTOS"

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Abstract: In this paper we describe the instructional principles that guided the design procedure of a hypermedia learning environment we call "ISTOS" (the Greek word for "Web"). ISTOS has been primarily designed as a hypermedia environment for supporting instruction in the Computer Networking domain but the instructional prescriptions underlying its design could also be followed in other instances. We propose that the rationale introduced by Cognitive Flexibility Theory for advanced instruction in complex and ill structured domains can be extended and combined with the prescriptions of Elaboration Theory, Anchored Instruction and Cognitive Apprenticeship approach so that hypermedia environments for introductory and intermediate learning in complex domains can successfully be built. We also underline the notion that domain knowledge in an educational setting can be presented both in a highly and in an ill structured way, allowing the students to experience the expository and the knowledge inquiry way of learning.

1 The Instructional Approach of ISTOS

ISTOS has been designed as a hypermedia educational environment for supporting instruction in the Computer Networking domain and is currently being developed as an application on Wintel machines. Instruction in ISTOS is organized in a series of levels. At each level a working educational model is in use. A model used at a certain level is a further elaboration of the previous one. At each level of instruction student/users are guided to work through three distinct loci of activities: Analysis, Synthesis and Apprenticeship. Analysis and Synthesis are based on the instructional prescriptions of Cognitive Flexibility Theory [Spiro & Jehng 1990 ; Jacobson et al. 1995] while Apprenticeship offers an environment for cognitive apprenticeship combined with "free" thematic criss crossing [Jacobson et al. 1995].

Analysis

ISTOS begins instruction by presenting and analyzing to the students representative cases of real-life problem situations (i.e. problems of computer networks installations or upgrades) thus anchoring the abstract knowledge structures to concrete problems. What we seek is to create "an anchor or focus that generates interest and enables students to identify and define problems and to pay attention to their own perception and comprehension of these problems" [Bransford et al. 1990, p.123]. Cases are divided into smaller case-sections in order to better organize and handle the complexity of the presented material and they are delivered through a variety of media: text, audio, graphics, animation and video. A glossary facility is provided so that further information on newly introduced concepts is available by mouse-clicking on hyper-linked keywords. The glossary constitutes an educational design aspect based on the existence of highly structured knowledge, i.e. information that remains

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unaltered and valid independently of the case under study (e.g. the concept of "network interface card", the concept of "synchronous transmission" etc.).
While browsing through cases, students are guided to study the "case-theme" commentary [Jacobson et al. 1995] that accompanies each case-section. These are comments that point out how a more abstract and structural characteristic of domain knowledge (a theme or concept) (e.g. the need for an efficient MAC protocol) applied in a specific way in the case studied (e.g. why Ethernet or Token-Ring protocol has been used). Fundamental in this design is the educational acceptance of the ill-structured characteristics of the domain, i.e. the introduction to the irregularity of application contexts.

Synthesis

In Synthesis student/users are guided to synthesize a more complex and in depth understanding of the presented material. A number of questions is provided and students are challenged to work out answers. ISTOS presents the questions accompanied by the relative themes and the case-sections where these themes appear and are commented. Students travel through hyperlinks to the case-sections to study the pointed out themes and formulate their answers. This is a thematic criss - crossing (TCC) activity similar to those applied in educational environments described by [Spiro & Jehng 1990] and [Jacobson et al. 1995]. Students engaged in this guided criss crossing are supposed to overcome the case - sensitiveness of concrete presentations and develop a more abstract, complex and multipathed understanding of the material presented.

Apprenticeship

Apprenticeship is a later phase of instruction where student/user plays the role of a Computer Networking expert challenged by domain problem situations and trying to formulate proper answers or solutions. The aim of Apprenticeship is to support both memory retention and deeper understanding by engaging student/users into knowledge inquiry activities. Students deal with "what" and "why" questions, with "optical recognition" questions and with real world scenarios which demand the proposal of an accepted network solution according to specific needs and restrictions. Student/users propose their answers by working in the "Network Editor", i.e. a special part of the program that allows them to edit the proposed network solution. The interface actions supported by Network Editor are supposed to exhibit "cognitive fidelity" [Collins 1996] to the real-life actions made by the expert. While in Apprenticeship students are asked to freely criss cross the cases [Jacobson et al. 1995] and create a list of case references by linking the problem situation to the cases on which they base their proposed network solution. Scaffolding to student answer-forming activities is offered by expert commentary emphasizing major points that students should bear in mind.

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Multimedia in Teacher Education: A Small College Approach

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Abstract: Colleges of education in the U. S. have been challenged to model and integrate technology use throughout their curriculum in order to better prepare future teachers to use technology in their professional practice. This paper reports on how one college education program is restructuring itself in order to meet this challenge, and focuses on how the program converted its traditional "media design" course to become "multimedia design."

Introduction

Although many advances in educational technology have been made in the past decade and U. S. schools continue to invest millions of dollars in educational hardware and software, the vast majority of the nation's K-12 teachers have failed to adopt technology use into their daily classroom teaching. According to a recent study conducted by the Office of Technology Assessment [U.S. Congress, 1995], part of the blame for this failure to adopt technology can be attributed to colleges of education that prepare teachers, for as the study reported, "One conclusion to be drawn is that telling students about what is possible is not enough; they must see technology used by their instructors, observe uses of technological tools in classrooms, and practice teaching with technologies themselves if they are to use these tools effectively in their own teaching"(p. 185). Colleges of education have been challenged by such reports to model and integrate technology use throughout their programs and to design new courses which will better prepare inservice teachers to use advanced multimedia technologies in their future classrooms. This paper will focus primarily on how one college program has redesigned its traditional educational media course for preservice teachers to become a multimedia design course, and will also share information about the department's overall three year technology infusion plan. Problems and possibilities with such a restructuring effort will be discussed.

Infusion Plan

As all long journeys begin with a single step, the first step for our education program was a department meeting in the spring of 1994 which was held to brainstorm and formulate an action plan. From this meeting arose a three year technology infusion plan, which included goals for faculty training, a restructuring of all teaching methodology courses to integrate technology use, and a technology acquisition schedule for the department [Drazdowski, Holodick, & Scappaticci 1996]. Though all the original goals have yet to be achieved by the department, the plan continues to act as a strategic decision-making guide and as focus for subsequent discussions and actions. A new technology plan for 1997-2000 will be drafted this summer.

Multimedia Design Course

The multimedia design course for preservice teachers became a reality in the spring of 1996 with the opening of the department's new computer lab. The computer lab consists of the following components: 12 PowerMac student workstations each connected to a laser disc player with separate color video monitors; 1 laser and 1 color inkjet printer; 1 flatbed scanner; 1 digital camera; 1 video camera, vcr, and a monitor (to produce QuickTime Movies); a large DA-LITE Screen; and a teacher station with like equipment on a multimedia cart that also includes a Syquest 135 EZ Drive and is all connected to a Sharp ceiling-mounted LCD projection system. The main software packages utilized in the course are HyperStudio 3.0 (Roger Wagner Publishing) and PowerPoint 4.0 (Microsoft). The main student text is *HyperStudio 3.0 In One Hour* by Vicki F. Sharp [see

Drazdowski 1996 for a review of this text]. All computers are linked to the college network and Netscape Navigator is available for Internet browsing. The students in the course are senior education majors, both elementary and secondary, who are in their "Professional Semester" and are about to begin their student teaching experience. Students work in collaborative pairs, actively constructing knowledge as they research topics and solve problems. The professor's role becomes that of guide, facilitator, coach, and scaffold builder. By the conclusion of the course students have created and presented many effective multimedia stacks on a plethora of topics, ranging from mitosis and the solar system to beginning Spanish, from eating healthy and dental hygiene to black history, from evolution and English grammar to the battle of Gettysburg, the plays of Shakespeare, and a tour of Paris. Any of these multimedia products can subsequently be utilized by the student teachers in their field placement settings.

Challenges and Conclusions

Our efforts to make lasting change in our program have met with many of the traditional barriers to change that have been identified in the literature, such as adequate access to technology, proper training for faculty, administrative and technical support, budget restrictions, and as Fullan [Fullan 1996] identifies, overload and fragmentation. But the most daunting obstacle to change the program has found to date is the lack of technology-rich environments and technology-using cooperating teachers in our students' field placement settings. Finding school cultures that promote and encourage innovation can be a difficult task. To help solve the technology access problem, our department has purchased two laptop computers and color LCD panels that can be checked out for field use by our student teachers, and many have taken the opportunity to do so. But in the long term it will take the combined efforts of school districts and colleges of education as well as consistent and appropriate funding from local, state, and federal sources to initiate and maintain change. It is only through such partnerships [U.S. Department of Education 1996] that we will be able to foster a generation of technology using educators, and only then will technology be able to finally fulfill its promise to transform teaching and provide more engaging learning opportunities and curricular innovations [Carrol 1997] for students in U. S. classrooms.

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ORGANISATIONAL FACTORS INFLUENCING ON-LINE REAL-TIME TELE-EVENTS

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Abstract: The attitudes of Scottish medical professionals to the introduction of a tele-education network as part of the training process for minimal access therapies were studied. A three phase investigation was carried out in order to identify the important strategic issues. This involved an initial questionnaire distributed to recognised tutors for minimal access techniques; in depth personal interviews with representative stakeholders involved in the organisational decision to join the video network and data collected using a Group Decision Support System at a workshop of clinicians unfamiliar with the system. The paper provides an account of the wide range of issues which the professionals identified as important during the selection and utilisation of video communications technologies for surgical training. A framework is proposed for analysing innovative IT or telecommunications projects.

This paper describes empirical research undertaken to determine the attitudes of Scottish medical professionals involved in the introduction of video conferencing technology in Minimal Access Therapy (MAT) training. It identifies the issues that medical professionals believe to be important with regard to their organisation's innovative use of IT. The respondents attitude and behaviour with regard to these issues will be discussed.

The National Health Service in the UK has undergone radical organisational change over the past decade, most especially with the creation of an internal market and of competition between previously collaborative providers of health care. At the same time, advances in medical science led to major changes in the way services were provided and this has had marked implications for the national provision of medical training (Cuschieri 1993).

This rapidly changing environment was the stimulus for the formation of MATTUS (Minimal Access Therapy Training Unit Scotland) and in particular the MATTUS video network for use in the training of postgraduate practitioners specialising in minimal access techniques. The establishment of a network of any significance required the participation of a number of geographically dispersed organisations with varying strategic priorities and differing degrees of openness to the use of developments in IT. While a number of telecommunications technologies are established, the uses of, and environment for, the proposed system meant that an innovative design required to be developed to suit the needs of medical users.

The investigation of the implementation was undertaken in three phases, consisting of a preliminary questionnaire, followed-up by semi-structured interviews and then a workshop. The questionnaire was distributed to all MAT (minimal Access therapies) clinical tutors in Scotland to elicit their attitudes to surgical training events, using real-time video and telecommunication systems. The study addressed system functionally, changes in established practice, and how these may best be disseminated. It also examined the effects of system implementation on the participants and process evaluation.

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The second phase consisted of in-depth personal interviews with representative stakeholders in the decision-making process for the proposed MAT video conferencing system. The interviews were conducted by an independent team to facilitate freedom of opinion. The stakeholders were categorised into three broad groups; medical professionals, non-medical business managers and IT specialists. The interviews provided a unique opportunity to gather the opinions of individuals involved in this pilot video conferencing project.

The third phase consisted of a 1-day workshop attended, 'virtually', by medical professionals, mainly postgraduate practitioners, all having experienced the MATTUS live video network. The workshop participants were geographically distributed around the three main Scottish sites. The workshop was organised to allow issues that had been raised in the previous information gathering phases, to be explored in greater detail and improve upon the quality and richness of existing data. It provided the opportunity for a range of both, organisational and individual issues to be considered pertaining to the participants perceptions of the role, appropriateness and effectiveness of video conference technologies and its eventual acceptance as a distributed medical training environment.

To facilitate the capturing and structuring of the data generated by the workshop participants a Group Decision Support System (GDSS), based on the cognitive mapping technique, was used (Eden & Galer 1990). This particular group support technology was used to structure and analyse the qualitative data. It is recognised that organisations use GDSS's when problems are complex (Eden 1992), as in the case of defining organisational factors for successful tele-events.

The paper provides an account of the issues which medical professionals determine as important during the selection and utilisation of video communication technologies pertaining to the dissemination and interaction of surgical skills training.

An outcome of this 3-phase research programme is a proposal and action plan to support organisations seeking to implement and manage live video networked tele-events. Issues addressed include strategic implications, financial constraints, intangible as well as tangible benefits and coping strategies to satisfy leadership and user expectations.

Whilst real-time on-line video network technology is maturing rapidly for the dissemination of surgical training skills in interactive environments, it is proposed that a repertoire of techniques must be added to the presentation skills toolbox to ensure that utilisation of the available technology is maximised.

A framework is proposed for analysing innovative IT or telecommunications projects. This is designed to highlight the key elements which may cause difficulty and draw the attention of the implementation team to issues which will promote efficient and effective design and adoption of video-based systems in medical training.

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Computer Conferencing to Support School-University Collaboration in Teacher Education—A Case Study

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Abstract: Teacher education is enriched when teacher candidates, associate teachers, and education faculty members discuss practicum experience and connect that discussion with work in education courses. A computer conferencing system was set up to support such interpretive discussion. Participants were given training, technical support, and suggestions on using the system in their professional practice. A study was designed to examine the form and substance of professional dialogue using telecommunications over a seven-month period that included two three-week practica. Participants acknowledged the potential of telecommunications, used e-mail as needed, but made very little use of the separate conferencing system. The paper examines these findings in terms of access, skills, and habits and interprets them in terms of technological change within the culture of teaching. The study is part of ongoing research and development to enhance collaboration between the university and schools in initiating teachers to their chosen profession.

1. Introduction

This paper reports on the voluntary use of telecommunications during the 1996-97 school year in a three-year project called Schools, Learning, and Telecommunications in Teacher Education (SLATE). In preparation for a new B.Ed. program having an extended practicum including school-based course work, the researchers wished to know how telecommunications might support collaboration between associate schools and the faculty.

Teacher candidates placed in SLATE schools for their practica were offered special opportunities: pre-practicum orientation visits to SLATE schools, working as a team during practica, collaborative teaching assessment, and workshops on computer applications including the use of a computer conferencing system.

The researchers explored how various telecommunications media—telephone, fax, e-mail, listserver lists, desktop video conferencing, and computer conferencing—fit the routines of teacher education, both to assist in organization, and in supporting professional dialogue. The researchers compared success in formally structured computer conference activities [Harasim 1995] with volunteer use.

2. The Telecommunications Study

Forty-six teacher candidates, 52 associate teachers, five principals (two secondary, three elementary), three vice principals, two faculty liaisons (the two researchers), and four research assistants collaborated in the study. Data were gathered through participant interviews, surveys, and field notes.

The researchers drew on experience in supporting teachers in the use of telecommunications [Egnatoff 1996] and on Danby's six years experience in administering a multi-faceted practicum program that had undergone recent major changes. The study was guided by a recent M.Ed. thesis [Christos 1996] on the SLATE Program that recommended more effective use of telecommunications to support professional development.

The telecommunications study examined patterns of use of e-mail and computer conferencing and explored the practicality of establishing a conferencing system for use by all teacher candidates in the B.Ed. program.

3. Preparing to Use E-mail And a Computer Conferencing System

The use of e-mail and of a listserver list for SLATE teacher candidates was readily established. Using e-mail had become part of the culture of university life and reliable infrastructure was in place. Establishing a separate conference system took the better part of a year: chosing suitable software (SoftArc's *FirstClass*), configuring a server on the Internet, and offering workshops, individual coaching, and support to participants.

No use was made of the system in the three elementary schools because Internet access was not readily accessible. The SLATE secondary schools could use the system because they had Internet access similar to what was available at the university, although with less bandwidth and hence slower response.

4. Findings: Voluntary Use of E-mail and Computer Conferencing

Two thirds of SLATE participants found e-mail valuable. Faculty-candidate exchanges dealt with announcements, practicum arrangements, SLATE surveys, and teaching. The number of messages per candidate ranged from 3 to 40. Faculty liaisons and school administrators also exchanged e-mail occasionally.

Use of the conferencing system was much less frequent and varied. Participants preferred other forms of communication. Candidates found it easy to talk amongst themselves and with their associates in the school. Most associates were not in the habit of regularly discussing their work as associates with one another. Most associates and candidates did not see any great need to share writing about their work with the faculty.

5. Summary and Discussion

This research report describes and analyzes a particular case of learning to use a new telecommunications medium while a faculty of education was undertaking significant program changes. The study was an opportunity to learn during the change, combining what had been learned in using telecommunications in the old program, in the 1996-97 pilot of the new program, and in the SLATE project. The study was an opportunity to document problems of access, the development of skills, and the establishment of habits of use of telecommunications at a time when access was being developed in schools.

In just a few years, use of e-mail at the university had moved rapidly along the path of growth, acceptance, standarization, and stagnation [Franklin 1990], shifting from a take-it-or-leave-it convenience to an institutional requirement. The same shift had begun in schools. Skills in using e-mail and a conferencing system were readily acquired, but habits of use for teacher education were governed very much by old habits of face-to-face communication and were strongly influenced by the lack of time to set reflections in writing. Given the option to take or leave the use of various media as teacher candidates saw fit, they took what fit well with their view of their work during the practicum, a component of the program quite distinct from university-based course work.

Bowers [Bowers 1988] construes what goes on in schools as an "ecology of relationships . . . regulated largely by the patterns (information codes handed down from the past) the participants have internalized as part of their taken-for-granted view of the world." The structure of the old program, with its short practica in which candidates found themselves fully pre-occupied keeping up with day-to-day preparation and classroom practice and with its separate blocks of university course work in which candidates were in different groups than their practicum groups, mitigated against the establishment of computer-based conferencing for collaborative reflection. Ongoing research will assess whether computer conferencing suits the habits of professional dialogue that emerge in the new B.Ed. program.

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TEECH: Forging an Electronic Community for Leaders of Teacher Enhancement Projects

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Abstract: TEECH (Teacher Enhancement Electronic Communications Hall *http://teech.terc.edu/*) is a three year project, funded by the National Science Foundation. It aims to advance the work of Teacher Enhancement projects by fostering increased collaboration among leaders in teacher development through the formation of an electronic community utilizing the Interment. TEECH draws on the strengths of over one thousand principal investigators and senior staff of teacher enhancement grants from the National Science Foundation, the US., State, and local Departments of Education. Its purpose is to encourage communication, collaboration, joint exploration, and pooling of this community's collective resources. This paper reports on challenges, strategies, and evaluation of this electronic community.

The users

TEECH, a project funded by NSF, aims to increase collaboration between leaders in the field of the field of teacher enhancement. These "leaders in the field" are primarily people who had written grants and received funding from the State or Federal government to improve aspects of teacher professional development. An initial needs survey (Falk, 1996) was sent out to 465 Principal Investigators and we received 255 responses, a 57% response rate . Their responses to our survey revealed that Principal Investigators (PIs) of teacher enhancement grants could not be considered as one cohesive community. The backgrounds of these PIs spanned a broad spectrum of expertise that included fields. The only factor that all PIs had in common was that they had obtained funding in order to conduct a teacher enhancement grant to improve math and science education k-12. Our initial needs survey showed that 91% of our users had access to the Interment. 84% replied that they had used e-mail, 56% had used gopher, 46% had used mailing lists, and 41% had used the World Wide Web.

While these Principal Investigators did not share a common background, a common professional vocabulary, or a common theory of teacher change, we hoped that they would use the diversity of their backgrounds to enrich each other. We were encouraged that they identified themselves as being most interested in discussing shared topics of concern such as Teacher Change, Professional Development, Assessment and Educational reform. In fact they rated these topics higher than their specific interest in either math or science or a specific grade level range to which their project was aimed.

The challenge

Unlike many virtual communities where users sign up because they have a desire to connect with others who share a special interest such as genealogy, or a love of Jane Austin novels, these principal investigators did not self create their community. The community was formed, in large part, because founders saw the need to improve collaboration, participation, dissemination between teacher enhancement projects so that projects could learn and profit from each other. This idea has clear merit. The challenge was to convince leaders in the field that such a community would help expedite their work rather than become yet another diversion and consumer of their time. Each of these investigators belong to smaller communities, which consist of staff who work on their project and other colleagues within an outside of their institution. How would this community add to the interactions that they were already having on subjects of Professional Development? Our challenge was exacerbated by the fact that many of these people were competing against each other for future rounds of educational funding. While they had a desire to share with each other there was often competitive edge. In addition, at the beginning of this project, while 96% of our population said that they had Interment access less than half (46%) reported having ever connected to the Web.

Strategies

During its first two years TEECH has developed multiple strategies to meet the needs of this community. These have included listservs moderated by leaders in the field, electronic seminars, on-line lectures given by leaders in the field made available on our Web site through Real Audio and text copies, and a database of PIs and their teacher enhancement projects. We also have made attempts to combine these formats, having a real audio discussion with a listserv connected to it.

Evaluating Participation

In *The Virtual Community*, Rheingold describes his first experience of being a part of a virtual community. He writes "I soon discovered that I was audience, performer and scriptwriter, along with my companions, in an ongoing improvisation." What we discovered on TEECH by looking at the interactions of our users was that not all members shared Rheingold's versatility for assuming each of those different roles. While some were performers who felt comfortable expressing their views others preferred to be the audience. Some investigators preferred to read papers than listserv dialogue which has an element of improvisation. Most preferred to read papers published on our site than to submit papers for publication. In the initial needs survey it was clear that of those who used the Web 53% used it to browse or retrieve information while only 35% used it to post to listservs or to publish.

Our multiple modes of interaction developed to serve different user types. Papers by leaders in the field and resources on critical subjects provide important core material for the users. Those who prefer the role of "audience" rather than performer can retrieve information without feeling that they have to post or publish. Those who want to contribute can do so. Lectures, similarly bring key speeches to investigators. These lectures provide audio, transcripts and overheads. Those who feel more comfortable experimenting with technology use the audio. Those who are more comfortable with text only view it in that mode. A searchable database allows Principal investigators to find other leaders with similar interests and also similar projects. They then can contact these projects by e-mail without being part of a large discussion. TEECH also has had several active discussion groups. Those who post are more comfortable in the "performer" role. they are also comfortable with the aspect of improvisation in that the conversation is organic and takes sometimes unexpected turns. In contrast, there are those who do not feel that they can join a moving dialogue. One user wrote:

> Why have I not actively participated thus far? I would say that lack of time has been the main reason. I have saved various messages, including your message of 2 weeks ago, with the intent to respond, but framing a brief thoughtful, response takes some time- and as time passes it seems that the heat of the opportunity has passed. Perhaps with time I will feel that I can just dash off a quick response or thought, but given the spunky nature of some of the discussion, I'd rather make sure that my words are appropriately chosen.

Yet, interestingly, we found that those "in the audience", silent participants of discussions who received the mail but never posted, also received a great deal of benefit. Following one very active listserv we sent a survey to both those who had posted and those who had not. Responses showed that both groups thought that the discussion was useful (95% of contributors, 82% of non contributors) and relevant to their project's work (86% of contributors, 82% of non contributors). While 67% of those who had posted shared the conversation with their colleagues, a similar 65% of silent participants had done so as well. The only area in which we saw a significant difference between contributors and silent participants was whether they corresponded or collaborated with a PI who had posted to the list. On this question 43% of active participants reported having had such a follow-up communication where as none of the silent participants reported doing so. (P=.002 by Fisher's Exact Test)

Lessons Learned

The TEECH community is very diverse. These Principal investigators are diverse not only in their professional fields, but in their comfort with the Interment and also in their interpersonal style of using it as a mode for communication. It is important to provide multiple avenues of interaction, for the performer to express and share the work that is being done, for the scriptwriter to be able to carefully craft papers for his peers, and for the audience who profits by the knowledge gained and by sharing with colleagues off line.

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Hypermedia and Learning Goals

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Abstract: In this paper we define our interest in hypermedia tools for learning, considering in particular the aspect of "learning by doing" and problem solving. Our interest is directed specifically in the field of mathematical education, and this is proved by our effort in designing and implementing hypermedia tools for teaching how to solve problems in different mathematical topics.

1 Hypermedia as Learning Strategy

Through hypermedia systems we believe to overcome, at least partially, the problems and the obstacles related to learning [Farinetti & Scarafiotti, 1995].

In a teaching and learning process we try to expand the knowledge base of the students, but we also try to communicate the knowledge of procedures and methods for studying and thinking, so as to involve the learner in an active and growing way. This task requires a good ability in encouraging the students' curiosity and interest, and in gaining their attention.

A teaching module supported by a hypermedia tool can encourage even the most reluctant teacher in "getting out of the desk", since the role of knowledge transmission is committed to the tool, in which the teacher sets his o her fantasy and creativity free; the hypermedia tool can become a "virtual friend" to study with, thinking over the subject in a personal way.

Specifically we agree with Marquesuzaa et al. [1996], who identify the goals of a hypermedia system that want to be an help for learning through the interaction between actors and methods: take better advantage of the facilities that multimedia technology provides, and help the users become more responsible for their progress.

What we said previously is particularly valid in the case of mathematics. The learning theories related to this discipline make the distinction between declarative knowledge (when we know the "facts") and procedural knowledge (when we are able to apply methods and strategies to solve problems); the more careful is the study of mathematics, the more evident is that learning is built through the creation of connections among concepts and processes.

Most researchers therefore believe that it is really important to guide learners in identifying not only the concepts but also the paths among them, looking for all the reasonable ones. The teachers then should help the students in decomposing a chapter A of mathematics, and in building it again according to a personal logic, obtaining a chapter A'; a distance exists between A and A', but A' is understandable and usable by the student; we can observe that the building of A in A' happens only if the user has in mind a context map of A.

In the text-books about mathematical learning, ample room is given to problem solving as a test for evaluating the learning process, and according to the philosophy of "learning by doing" [Farinetti & Scarafiotti, 1996]. We therefore have great expectations about hypermedia tools that help the process of solving didactic problems. In addiction to this, open hypermedia tool will give the teachers the opportunity of making their problem collection grow, offering a didactically valid framework for building questions.

A good hypermedia system will therefore be designed according to cognitive apprenticeship requirements, and will give particular attention to six fundamental aspects in the learning process:

a) modeling and explaining: understanding the model of what we have to learn is the first step in learning; a hypermedia tool which shows and explains the reasons why something happens is likely to grab the attention of the students and to motivate them more than many words;

b) coaching: hints and feedback can guide the students in performing their tasks; a computer teacher is infinitely more patient than a real one.

c) scaffolding: the support level of the teacher changes according to the increase of the students' skill, and gradually disappears; a hypermedia tool can provide different educational paths for different skill levels, or can be programmed to change its behavior dynamically;

d) articulation: a consolidation of learning happens when the students are encouraged to think of what they are studying from different perspectives; a hypermedia tool can offer the integration of many different points of view and link them together, leaving to the student the task of understanding the real meanings of the links;

e) reflection on performance: evaluation or self-evaluation is fundamental for correcting errors and misconceptions in the building of knowledge; hypermedia tools can offer different ways for performing this task;

f) exploration: the comparison between different methods and procedures for problem solving helps the students acquire their personal strategies and stimulates their creativity; hypermedia tools can list different methods, relate them in the case of one exercise or among many exercises through the use of analogies and similarities.

2 The Design of a Tool for Learning Numerical Analysis

The tool is essentially a collection of exercises with helps, hints and solutions. We defined three different categories of exercises:

a) quizzes
b) step by step exercises
c) complex exercises

The exercises of categories a) and b) are grouped according to the topics of numerical analysis; category c) contains exercises that consider the whole content of the course. The level of difficulty in each category increases from one problem to the following one.

The student studies a topic, solve the problems of category a) related to it, deals with the related exercises of category b), and moves to the following argument; after having considered all the topics, he can check his level of knowledge solving again all the exercises of category a) and using the feedback to revise the contents. Finally he can solve the exercises of category c) for testing his skill in using general strategies and procedures.

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New Media Enhanced Education: more than to add new resources

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Teachers and educators are worried about how to take advantage of newmedia and/or new technologies. But they focus the problem from theperspective of the introduction of new resources that would help to reachold objectives, and, some times, with old methodologies. The mediaare used in the service of memorizing, of structured learning, ofreproductive teaching as denounced by Freire, of knowledge as a contentthat you can to move from one recipient to other as Popper criticized.

When we use the new media in our educational systems, we must beconscious of the changes that these media have produced in our society,because we are wrong if we think that we will be able of filling the oldbarrels with this new wine without problems. This paper shows asynthesis of our work during the last years, synthesis that we presentaround two key ideas: Education in a show-culture, Education in aparticipation-culture.

We know that some of the ideas of this paper will sound strange, andthey can to generate a strong controversy, specially between not technologynear teachers and professors. In so few pages it is difficult to developthese ideas in depth. And we both are not-English speakers. However,read carefully the next lines and reflect on them.

A. Education in a show-culture

For the first time in the history of Humanity it is possible toassert that we live in a culture of the show. And this is not only becausethe Audiovisual Communication technologies put every kind of spectacles atcitizen's disposal 24 over 24 hours, but also because thosetransform in spectacle every reality when touched: from electoral shows toelectronic churches. How does it affects to education? How to educate in ashow-culture?

The first to do for a lucid educator is to become aware of personalchanges imposed by cultural changes. Diverse cultures, when they imposechanges in communication instruments and expression forms, they finish upby imposing changes in perceptive habits, mental processes,attitudes, preferences. In other words, cultural changes derive inperceptive, attitudinal and mental changes. Every communication worker thataspires to be effective in a cultural change age has to adapt tomodifications that the new culture imposes in the receivers. Whichones are the changes derived from a show-culture? We can to distinguishbetween modifications at perceptive level, at mental level and at attitudeslevel.

1. From a perceptive point of view, the iconosphere culture move tofavour the feelings over the thoughts. In a show-culture it is moreimportant to contemplate than to think. It outweighs the concrete over theabstraction. It favours the sensibility over the reflections,dynamic over abstract dimensions. The show-culture is the culture of senseshyperstimulation, visual as well as sonorous one. It is the culture of thefear to the silence, of the rejection of the static state. It is theculture of "zapping", of the continuous perceptive change, of thesenses reward, of the accelerated rhythm, of the vertigo.

2. From a cognitive point of view, the show-culture move to favourwhat is emotive over what is rational, simultaneous over linear, intuitiveover thoughtful. The iconosphere culture contributes to power the kingdomof the emotion over that of the reason. It does not mind so much ifit agrees with the represented reality, from an ideologic point of view aswell as from an ethic one, as if it likes, it satisfies, usually at mostelemental level. It is the culture of the hypertrophy of emotions asconsequence of the senses saturation, but also it is the culture ofcontinuous use of the psychological mechanisms of identification withrepresented characters and of the projection of diverse feelings tospectators.

From the mental point of view, the show-culture represents at thesame time a different manner of understanding the world, not in a linearway but in a simultaneous one, not in an analytical way but in a syntheticone, no in a rational way, but in an intuitive one. From thesystematized and hierarchical humanist culture it is passed to mosaicculture, characterized by the dispersion and the random chaos. It is aradical different form of constructing, not so much from cause-effectrelation processes as from the simple association, from the relationby contiguity or similarity.

3.These modifications have their repercussions in the sphere ofattitudes. For instance, the "zapping" -use of remote control to jumpcontinuously from one channel to other- stops being only a behaviour infront of TV set, to convert in a vital attitude. At every level ofour lives, it is moved from the possibility of change to the necessity ofchange. The space and the time are not lived in a linear way but in asimultaneous one. From "a time for each thing" to "every thing at the sametime". The emotional reactions are moved to favour over rational.The show-culture is, definitively the culture of zapping, of hypertrophy offeelings, of kingdom of senses, of intuitive thought.

The educator could to react in front of this analysis arguing theneed of compensatory measures. He/she could to allege that what educationalinstitutions have to do is filling the empty spaces that this show-culturehas created. He/she also could to defend that Education must besituated in the opposite of described parameter, to face up to theexaggerations of this show-culture. This is not valid option because itwill not be educationally effective. Of course, it is essential thateducator compensates the generated voids, but this has not to bedone -it cannot to be done- from communication parameters opposed to thisculture. If education is, primarily a communication process, it will beeffective only if it is capable of connecting, of syntonizing with the receptor of its own discourse. And to syntonize with receptors moldedby this show-culture it is necessary to start from the same parameterimposed by this culture. If the new media have deeply modified the culturewhere they have born, and if this has deeply modified the way we seeand think, it is essential that education knows to modify deeply also itsown schemes and criteria to adapt to these modified subjects. To modifyitself not to renounce its objectives but to remain faithful in theessential to them.

To educate in a show-culture has to implicate to assume a certainprimacy of the concrete, of the senses, of the feelings. To make agile therhythm of teaching/learning process. To incorporate visual, intuitive,global, dynamic methodologies and strategies. To educate in thisculture implies to assume these values but not to remain in these, notconsidering them as an absolute reference, but using as springboard, aslever, as power, as catapult, as motor to improve procedures that take tocritical analysis, to abstraction, to reflection.

B. Education in a participation-culture

To define our culture as a participation-culture requires amultidisciplinary analysis: from the sociology, from the politicalanalysis, from the social psychology... Here we are going to explore howthe dominant technology is evolving toward an interactivetechnology, and its applications change more and more toward participativeones.

In any case, ours is not the first culture with high participationlevels. And it is not the first one where this participation is stopped inits way toward the actual taking of decisions. Knowing and appropriatingthe participation mechanisms is a step forward to a democraticpower. Day after day we are being convinced that today the democraticparticipation is based not only or not primarily in the voting, electoralcampaigns or in the demonstrations, meetings,... but in the access tocommunication media.

During the last decades it has been assumed that Information ispower, that the control of Media is power. Perhaps, the starting point wasthe propaganda policy of Nazi government, in Germany at 30's. So, theparliamentary actuations or street demonstrations are, more thanpower instruments, means to get the access to great Media, authentic powersupplier. But this is changing.

What is changing is the old discourse that conceives the informationas a power source controlled by a few ones, as described by Ramonet (1980)or, in a more entertained and right way, by Jerry Mander (1977) whenremembered that McLuhan used to speak of a global village with adrum, but that McLuhan had forgotten that there was only one drum, and onlya few people played it.

How is it producing this change, that I consider still in itsbeginnings? I think that there are several factors derived from theevolution of technology, that are determining the change. Other factors arerelated with a society based in the consumption, and that it dependsof consumers to run on.

As consequence of the technological development and of the rules ofthis liberal and consumption based society, the television is characterizedby:
. multiplicity of programmes: specialized channels
. multiplicity of dealers
. multiplicity of channels: cable, satellite, Internet....

If we begin from the lowest level of this reality, we find the"zapping" or continuous use of remote control jumping from one channel toother. We can to analyze deeply this use: before the spectator sat in acomfortable sofa opposite the tv-set to "watch what there is". Now,the situation is similar but with the remote control in one hand, takingdecisions about what to watch. Of course, the spectator has been lesspassive than it seems. But the difference that now he is taking thesedecisions. And these ones involve the need of defending the owndecisions in front the other sofa's companions. Well, I am speaking of mychildren, 4 and 8 years, discussing and selecting the preferredprograms.

Higher in the scale, we can find new participation forms, arriving to"tv-broadcasted games" but always in this centralized or in-a-star-waydistribution of information. And we find the "tv a la carte": now thespectator does not choose between a limited number of actuallybroadcasting channels but he/she selects one program that begins to bereproduced specifically for him/her at this moment. And we can arrive to TVby Internet as the Vivo Software Inc. proposal (http://www.vivo.com).

The next step is to move from receptor to transmitter. The formertechnology let the community channels by cable, the local broadcastcenters, alternative transmitter, video distribution, counterinformation...but today with Internet the audience can to be as wide as theplanet.

This takes us to a change in the conception of communication: fromaudiovisual to multimedia (Hodges & Sasnett, 1993), from one-way to two-way(Gayeski & Williams, 1985), from information distribution oriented systemsto participation oriented systems. If, as Victor Hugo said, there isnot anything so powerful as an idea that finds its time, today the GlobalVillage of McLuhan (1964) is finding its time thanks to Internet, but it isa new village where it does not mind so much the drum as this assemblywith a participation so far and so near to some descriptions ofMargaret Mead, but, this time, "cyborg citizens in electronic agoras"(Mitchell, 1995).

To educate in a participation-culture supposes to educate in the useof the technology to communicate with all the world, to let our own voicebe heard, to stablish networks over the borders, to generate the owninformation, to access to relevant information where it is. Theelections at school, the social education... are important resources butthe socializing process today has to be based in the technology. A socialeducator without access to technology is, today, an educator that has losthis/her arm, the right. An Education that does not prepare for thistechnology of participation, is seeding obstacles in the democracy path.

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EDUCATIONAL TECHNOLOGY AND PRESERVICE TEACHERS

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Abstract

At Wright State University, education students construct a professional portfolio that documents the pre-service teacher's growth. The portfolios are modified throughout their program and may be used with potential employers. Now the students create web pages that serve the same basic purpose and access to hypermedia. The webpage may provide hyperlinks to instructional resources in the student's area of concentration, and has the added benefit of video clips that illustrate the pre-service teacher in action. The use of this electronic may also serve to demonstrate the candidate's mastery of educational technology.

Educational technology, as defined by Awbrey (1996) is "a dynamic system -- employing a combination of human and non-human resources to create effective learning environments." It is imperative that hypermedia, multi-media and telecommunications become as commonplace as chalkboards and textbooks in that learning environment. Recognizing the importance of educational technology, the National Council for Accreditation of Teacher Education (NCATE) requires preservice programs at colleges and universities to include educational technology in all coursework in which early childhood, elementary and secondary level teachers are prepared (Richardson, 1994).

The Teacher Education Department at Wright State University (WSU) in Dayton, Ohio is taking that requirement very seriously. Pre-service teachers conduct on-line searches to locate publications from a variety of sources; use electronic retrieval systems, such as ERIC and search engines, like Yahoo and Alta Vista, to locate and download research from on-line journals. In presenting their term papers, students model "best practices" by designing and presenting multimedia presentations using applications such as *Hyperstudio, Power Point, Astound, Digital Chisel* and others. In addition to accessing the internet for on-line chatting and conferring with their professors, Wright State's education students discuss topics and debate questions posed by professors and others in their classes via listserves and user groups. As a study in comparative education, students may choose to interact with education students in other parts of the United States and Europe.

At Wright State University, education students construct a professional portfolio that documents "Teacher as problem-solver", the model on which WSU's teacher education program is based. These portfolios include an auto-biography, a resume, a discussion of educational philosophy; a self-evaluation of personal strengths, and measures of teaching and learning styles. Students reflect on specific skills in which improvement may be needed. Records of field experiences, pictures of classes with whom the pre-service teacher has worked are also retained. Documentation of expertise in major academic areas as well as congratulatory announcements and letters of recommendation is also housed there.

In addition to the "hard copy," other electronic formats of the professional portfolio have been considered. Pages of a the portfolio were scanned and pressed into a compact disk format. Although very portable, the CD format does not lend itself to frequent updates. In addition, paper copies, such as transcripts and letters, are not as readable in a CD format as they are in the original and the scanning of photos and graphics makes high memory demands. Pre-packaged portfolio programs, such as the Grady Profile and Scholastic's Electronic Portfolio are available to collect samples of student work and may include photos, pictures and other art work that has been scanned.

Another format for the portfolio that offers easy updating, almost unlimited memory, flexibility, easy accessibility and opportunity to utilize other forms of educational technology is the web page portfolio. In one section of teacher education classes, each of the 21 pre-service teachers was constructed an 8-10 page personal, professional web page that is located on the Wright State's College of Education server (www.ed.wright.edu). A couple of students chose to write their web page in html, some utilized Adobe's *Pagemill* or other applications from on-line services, such as Busy Teachers web page for web site construction. These student web pages include much of the same information as the traditional hard copy portfolio, with the addition of Quicktime movies -- short video clips showing the pre-service teacher in action. Students designed their pages according to personal preferences and often reflected their area of concentration (social studies, language arts, etc.), level of certification (elementary, secondary, etc.) and outside interests (hiking, biking, etc.) in their theme, backgrounds, and/or images. Students' web pages also included an area in which they posted the addresses of "favorite web sites." These URLs provided quick access to locations of personal interest, as well as home pages of educational organization (ASCD, NEA, AFT, etc.), and resources for teaching in the students' areas of concentration.

As the students' level of comfort with and expertise in using educational technology develops, their portfolios will be modified and reflect this growth. Students will continue to update their traditional hard copy portfolio as they update their web pages. When students are seeking their first teaching positions, they will be able to present their hard copy portfolios to their potential employer as evidence of their skills or, if the employer has access to the Internet, be able to log into the Wright State University Homepage and demonstrate their skills.

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LEARNING PROOF TECHNIQUES THROUGH VISUALIZATION

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Abstract: The art of constructing a mathematical proof remains a challenge to large numbers of students. Constructing a proof is a challenge to teach. It is also a challenge to learn, understand, and appreciate. This paper describes a proof tutor, a web-based application that provides students with reinforcement in the several components of proof construction, given a mathematical statement to prove. The application supports the learner in choosing an appropriate method of proof, then guides each step in the proof, using user-selection of step rationale as well as visualization of the mathematical process involved in moving from the current step to the next. Performance support is provided in the form of a linked mathematics dictionary.

The Motivation

The teaching and learning of what constitutes a sound mathematical proof is an acknowledged problem in mathematics education [Solow 1990]. The abstract nature of proof seems to be such a mystery to the majority of students that it often is disguised as something less intimidating, or even passed over in a general curriculum. The application discussed in this paper was designed for students taking a course in discrete mathematics, where a large part of the course content is the mastery of proof. The objective of this application is to strengthen the user's understanding of the process of mathematical thought while reinforcing a systematic approach to the construction of proof. Because the students' background in algebraic manipulation is often weak, performance support is provided through the inclusion of links to an on-line mathematics dictionary.

The Learning Environment

This application is used in two ways: by an instructor in the classroom to enhance the lecture experience, and by on-line use of a learner to reinforce the material. It can also be used for self-learning in lieu of classroom experience, although we have not had experience with this approach.

Guidance Through the Process of Proof

The application can be approached from two directions. Either the user may be given a random mathematical statement to prove, with the user choosing the method of proof, or the user may ask to practice a particular method of proof, in which case appropriate example statements will be displayed. For some methods of proof, such as mathematical induction, part of the process of establishing method is to lead the user into articulating both the starting point and the desired final statement, so that the success of each intermediate step may be evaluated. For other methods, such as direct proof, the "opening statement" is not always clear, and so the user is directed towards forming an opening position that is likely to lead to success [Levine 1994]. Once the user has a statement to prove, and an approved method to follow, the step by step process is guided. At each step the user is given a choice of mathematical definitions or laws that might or might not be suitable means by which to move along a path towards reaching the desired conclusion.

Several of the laws (or rules) used to advance a proof are animated for the user once a choice has been made, such as application of association, commutation, distribution, modus tollens, modus ponens, and transitivity. The development of the animation of the application of laws of mathematics and logic to expressions or statements is an on-going process.

Use of Performance Support

An associated computer-based application, MathDef [Fritz 1996], is integrated into our proof tutor insofar as any term that is not familiar to the user, or for which the user needs refreshing, can be linked to the definition available within MathDef. Additionally, MathDef is a multi-level dictionary, so that an expanded explanation of term is available for several topics.

Portability of Technique

This project is in the process of being ported from ToolBook to the Web to expand its portability. It also is portable with regard to use. It can be used for current course work and for remedial study; it can be used to enhance teaching by an instructor and to provide self-study for a student. It is felt that the presentation methods used in the proof tutor can be used with effective results in other areas of mathematics teaching.

Future Work

This is an on-going project that continues to build functionality in terms of: the animation of the application of mathematical laws to expressions; the number of proof methods that are accommodated; and, the degree of interaction with the user. As well, the supporting application, MathDef, continues to be expanded in both the collection of definitions of terms and in the number of those terms for which further levels of explanation are available.

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The Nechako Electronic Busing Program™; Distance education options for K-10 students

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Abstract

Schools are being faced with a myriad of internal and external forces that demand change. In an attempt to reconcile crowded classrooms, lack of resources and diverse family values, many families are seeking educational alternatives. The Nechako Electronic Busing Program™ is an electronically mediated K-10 distance education program that supports parents in the education of their children in non-traditional settings.

A recent addition to the field of distance education in British Columbia is an innovative program called the Nechako Electronic Busing ProgramTM. Located in the geographic centre of British Columbia, School District 91 (Nechako Lakes) enrolls approximately 5500 students in 20 public schools. These students are distributed throughout 8 communities that are separated by 40 to 100 kilometers of sparsely populated agricultural land. Yet one small elementary school of 90 students also enrolls an additional 440 students from all across the province of British Columbia. These are the students of the Nechako Electronic Busing ProgramTM.

Many parents, for a wide variety of reasons, have chosen non traditional methods of schooling for their children. The most common alternative is to school the children at home under the direction and guidance of the parents. Whether these decisions are made for philosophical or pragmatic reasons, few, if any, support services are offered by the public school system. In the early months of 1993, a small group of parents approached School District 91 (Nechako Lakes) with a request for assistance. These parents wanted to continue to be responsible for the education of their children, but they also wanted to be able to discuss educational issues and to be supported by a certified teacher.

In order to respond to this request, the District took the opportunity to pilot a unique concept it had been exploring; an electronically mediated distance education program. Each of the thirteen families were provided with an Apple IIe computer, a modem and an e-mail account in order to communicate with an assigned teacher on-line. Families consulted with the teacher and each other on issues ranging from pedagogical concerns such as curriculum, assessment and evaluation, to more pedestrian communiqués that dealt with the arrangement of group picnics and skating events. This proved to be such a constructive and successful pilot project, that it was expanded to enroll 225 students from 13 other school districts in the fall of 1994.

The model used by the Electronic Busing ProgramTM is built on a high degree of trust. Parents want what is best for their children and want the educational program they use to accommodate the child's unique needs rather than the educational system's needs. The Electronic Busing ProgramTM has tried to make this flexibility possible. Teachers on-line articulate the Ministry of Education's curricular learning outcomes to parents, provide assistance in planning and preparing a student learning plan, suggest appropriate resources to support such a plan, and offer assistance to the parent in selecting samples of student work that can be used to demonstrate that the outcomes are indeed being met.

Teachers on-line do not lay out a course of studies that all students must complete. Instead , they work directly with parents in helping them meet the child's individual needs. This type of approach works well with parents who desire a high level of involvement in their child's education and have a high level of commitment. It may not work well for all families but what it does provide is an unprecedented level of flexibility and control being placed in the hands of the parents who are treated as true partners in the process. There are many ways to achieve the learning outcomes described in the Integrated Resource Packages, and thus the choice of when, and how particular learning outcomes will be addressed is left in the hands of the parents.

Students are not assigned to teachers on the basis of traditional age/grade/subject groupings but as family groups located in specific geographic areas. This may stretch the skills of the on-line teaching staff, but it has so far facilitated better and more efficient communication between parents and teachers online, allowed for the natural integration of curriculum across grade and subject boundaries, and simplified the process of reporting. Recent discussions have centered around the notion of creating broad groupings of students (primary, intermediate, junior secondary) but while this move might capitalize on certain teaching skills and experiences, it might create problems for parents in terms of working with several teachers in an online setting. Parents may be offered the choice of working within the framework of a family grouping or working with several different teachers according to the approximate grade levels of their children.

A ministerial review of the program occurred in the spring of 1995, and the major recommendations indicated that in order to receive future funding, the families of the Nechako Electronic Busing ProgramTM would have to adhere to the British Columbia curricular learning outcomes and the progress of the students would have to be accounted for. Prior to this time, families were encouraged to follow B.C. curriculum and they were encouraged to participate in the credentialling process. This, however, had not been a requirement. The results of the review process were clear, however; failure to move the program to have all participating parents adhere to B.C. curricular outcomes and to have teachers account for student progress would result in the removal of provincial funding. For some families, these changes presented philosophical conflicts that caused them to leave the program, but the vast majority returned for the 1995-96 school year.

Steps were taken in the 1995-96 school year to establish policies and procedures to facilitate the Ministry's adherence and accountability directives. A great deal of discussion within the program focused on the pending changes and how families could supply sufficient evidence for teachers to make a professional judgment of students' progress. For students in the elementary grades (K-7), parents would minimally submit a learning plan outlining the learning outcomes students would be working on. At the end of the term they would indicate which outcomes had been completed, and they would provide sufficient evidences of student learning in order for the teacher on-line to determine that satisfactory progress was being made.

Students in the junior secondary grades must follow a more rigorous model and submit sufficient evidence for outcomes they have completed in each of the curricular areas. The educational programs of students in Grades 8 to 10 are more structured than those of the earlier grades, and this is due to the content-driven nature of the courses. Upon the submission of sufficient evidence for each learning outcome and curricular area, students are assigned a satisfactory grade. For grades beyond a C, criteria are developed and communicated at the beginning of each term.

Another review of the program was conducted in June 1996 to ascertain how the program planned to deal with the Ministry directives of adherence and accountability. It was determined that there were clear policies and procedures in place to ensure adherence and accountability and that the Ministry's expectations were achieved. As of October 21, 1996, the Nechako Electronic Busing ProgramTM became recognized and funded as an electronic distance education program for the province of British Columbia, enrolling approximately 440 students from all across the province.

At present, each family enters into a payment free lease agreement with the District for a multimedia Pentium PC that is equipped with a 28.8 fax/data modem. Further, each family is provided with:
· access to the Internet, e-mail and toll free voice access to an teacher-on-line
· ongoing training and support in the use of technology for educational purposes
· a bundle of educational courseware produced by the Computer Curriculum Corporation
· access to the E-Bus TM WebSite which contains British Columbia curriculum learning outcomes, support for instruction and support for evaluation
· a resource allocation of approximately $200 per full-time equivalent student to purchase materials to support the child's learning program.

Parents continue to assume the role of the primary instructor of their children. They are adhering to British Columbia provincial learning outcomes and are responsible to choose whatever resources and pedagogy that they determine are best for their child's learning situation. Further, samples of student work are shared with a teacher-on-line so that report cards may be written. In the intermediate and secondary grades, criteria are offered for students who wish to achieve marks above a satisfactory level.

The Nechako Electronic Busing ProgramTM does not fulfill the needs of all students or families. It provides a very real alternative to conventional models of public education for parents who want a direct involvement in their children's education, an alternative to overcrowded schools, an escape from unsafe learning environments and allows for the provision of additional curricular pursuits the students or parents choose.

The future of the Nechako Electronic Busing ProgramTM is exciting and promising. Partnerships are being developed with other educational jurisdictions to allow for the provision of services that draw on the experiences gleaned to date. We are also exploring ways to incorporate this program model into other educational settings such as storefront schools and non traditional classrooms. Steps are currently being taken to streamline the evaluation and reporting of student growth and to develop programs for the senior high school sector. Other national and international markets are being explored.

The Nechako Electronic Busing ProgramTM provides a model of elementary and middle school education that draws on the strengths of committed parents, the tools of electronically mediated communication and the experiences of a group of professional distance educators.

Assignment Responses as a Function of On-line versus Classroom Presentations of a Course on Dreams

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Abstract: Three groups of students were separately taught introductory material on dreams in either a traditional classroom setting, a mixed classroom and on-line setting, or in a completely on-line setting. After this material was presented their attitudes towards dreams were assessed. After confounding variables were controlled, only one of the nine dependent variables showed a sample effect. Therefore mode of presentation in general does not affect the attitudinal responses to the material at least when it comes to an introduction to dreams.

In the fall of 1995 I was asked to develop an on-line, non-credit course for a local community college in my area of expertise, dreams. "Unlocking the Secret of Your Dreams" consists of five lessons which teaches the student to interpret and work with their own dreams, both alone and in an electronic group sessions. Each lesson is accompanied by an assignment where students put what they have learned into practice, and answer a questionnaire about their experiences. A more detail on the registration page for the course (http://www.outreach.org/dreams).

Parts of this course have been or are currently being administered in a variety of settings including traditional classroom teaching, a combination of traditional classroom teaching and on-line presentation and only on-line presentation. The purpose of the present paper is to compare some of the responses of the students to the same questions about the course activities as a function of the setting in which the materials are delivered.

Method

In the fall of 1995 part of the first assignment was given to students in an Introductory Psychology class I was teaching following an introductory lecture on dreams. The lecture material was essentially the same as that presented in the first lesson of the on-line course. This data is compared to the first assignment responses of the beta subjects, who agreed to test the course at no charge in the spring of 1996 and a third sample of students enrolled in a course on sleep and dreams in a classroom setting, who took the on-line dream course as part of the Sleep and Dreams course requirements. This third sample provides a link between the purely classroom students experience and the experience of the purely on-line student.

The Introductory Psychology students were 16 males and 15 females almost half of whom English was not their first language (48%). A bit more than a third were Asian or Oriental with slightly less than half of European ancestry. Most of the students were in their 20's with 39% being first borns or only children. The beta students volunteered to participate in the course through informal networks of the author/instructor. Although 43 registered, only 26 completed the first assignment, 12 of the 16 registered males and 14 of the 27 registered females. Their average age was mid-40's with 65% first borns or only children. Most were employed full time. The vast majority (88%) spoke English as their first language and 81% were of European ancestry. Finally, the majority of the students enrolled in Sleep and Dreams were female (n=23) with only 8 males in the class. These students were also in their early 20's with as many first borns or only children as later borns. English was their first language for all but one of the students while three were of non-European ethnic background. It can be seen that in addition to receiving the course materials in very different settings, these three groups of people are different in other ways.

Questions that all three student groups answered included demographics (sex, birth order, first language, and ethnic background) and questions about their sleep and dream habits (had they ever kept a dream diary, hours of sleep, and dreams recalled per month). They were also asked the degree of importance of religion in their lives. An abbreviated version of the Dream Response Questionnaire (DRQ) was also included in the questionnaire/assignment. This is scored along eight dimensions of attitudes towards dreams. For the on-line version of the questionnaire information regarding items belonging to subscales was available for the student as they took the questionnaire while it was not available for the Introductory Psychology students who took the questionnaire in a paper and pencil form during class. This shortened version of the DRQ was scored as a function of subscales and a total scale score. The subscales were Insight, Discuss, Spiritual, Leisure/escape, Vivid imagery, Reject, Author/style, and Storydriven.

Results/Discussion

The information available on the three samples of students was classified into two types. Variables which represent the characteristics of the student and those which may have been affected by the course material (in reading/lecture). The first set of variables included sex of subject, birth order, first language, ethnic background, dream diary history, importance of religion, hours of sleep per night and dreams recalled per month. The scores on the DRQ subscales and full scale score constitute variables which reasonably may have been affected by the content of the material on dreams.

As mentioned above the three samples of students varied in a number of ways besides their course enrollment. Therefore a varimax factor analysis was calculated on the subject characteristics in order to determine which variables covaried with sample. Sample loaded most strongly on the first two factors. Specifically, on the first factor the more electronic the presentation the higher the dream recall per month and the more likely the student was to have kept a dream diary. The second factor showed that electronic presentation was associated with English speaking European ancestry in females. Based on this analysis dream recall, sex of subject and language/ethnic background were controlled for in all subsequent analyses in a variety of ways. All students with non-European ethnic background who did not speak English as their first language were deleted. This left 63 subjects; 15 from the Introductory Psychology class (no electronic component condition), 28 from the Sleep and Dreams class (both electronic and classroom condition) and 20 from the Beta class (all electronic presentation condition).

Dream recall was controlled by using it as a covariant in all subsequent analyses. Number of dreams recalled per month was used rather than history of keeping a dream diary as the former is more sensitive to individual differences than the yes/no response category used for dream diary history. Sex of subject was controlled by using it as a between subject variable. This is further justified by the strong precedence in the dream literature for consistent sex differences in dreaming attitudes and styles. By controlling for the known covariants in these ways findings from comparisons between samples/conditions can be said to more closely approximate differences in presentation of the material rather than group content differences.

Nine analyses of covariance with two between subject independent variables (sex of subject: male and female; condition: no electronic presentation [Introductory Psychology], some electronic presentation [Sleep and Dreams] and all electronic presentation [Beta class]) were then calculated on the scores of the eight subscales of the DRQ and on the DRQ sum score. In all cases high scores indicates a positive attitude towards dreams. There were no main effects or interactions with dream recall controlled for the ANCOVA's calculated on Leisure/escape, Rejection, Insight, Storydriven, Discuss and Vivid Imagery subscale scores.

A significant main effects occurred in the ANCOVA for Author/style while those for Spirituality and for the DRQ sum score analyses approached significance. For the Author/style analyses a main effect for condition (F(2,49)=3.76, p=.03) occurred. Students in the electronic condition/Beta class (mean=3.25) were significantly more likely to be sensitive to the dreams style of story telling than the mixed media class (Sleep and Dreams; mean=2.63) but did not differ from the nonelectronic presentation (Introductory Psychology; mean=3.03) students.

The other subscale to result in near significant condition differences was Spirituality. Here the sex by condition interaction approached significance (F(2,51)=2.569, p=.0865). It was the males in the nonelectronic (Introductory Psychology) condition which accounted in the main for the interaction. Specifically they were considerably less likely to report using their dreams for spiritual purposes than all other students who reported moderate usage. The final ANCOVA was on DRQ sum scores. The condition main effect without dream control approached significance (F(2,48)=2.556, p=.0881) such that the mixed condition students had the lowest sum scores, although Fisher's a-postori test resulted in no group differences (Introductory Psychology mean=24.9; Sleep and Dreams mean = 24.796; and Beta Class mean = 24.944).

In conclusion, since the only unequivocal finding was for one of the nine DRQ dependent variables while two showed marginal results, it must be concluded that style of presentation does not in general affect the outcome of the impact of material on the students at least in a dream course.

SAMI (C-L2): Development and Evaluation of a Multimedia Cooperative Learning System

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Abstract: We have developed two prototypes of a multimedia learning system. The first prototype is designed specifically for cooperative learning. It includes various strategies which may enhance interactions between two students working at the computer. The second prototype includes only features that are recommended for cooperative learning, but that could also be found in multimedia systems designed for individual learning. The content of both of these learning systems is based on oral and written comprehension objectives drawn from the ESL (English as a Second Language) curriculum for grade 5 students. Interactions between students will be monitored in order to determine the type and number of interactions generated during the different activities. This project is the subject of a doctoral thesis supervised by Professor Philippe Marton.

1. Theoretical considerations

Cooperative learning involves learning in groups through structured activities designed to improve learning through the development of social skills. The verbal activity taking place between team members, particularly asking for and giving explanations [Webb 1985], seems to play a role in improving performance. "Learning Together" [Johnson, Johnson and Holubec 1993] details several elements that are fundamental to a cooperative learning environment. In the field of language education, a few studies [Chang and Smith 1991] have been conducted concerning small group learning at the computer. In those studies that did attempt to give a certain structure to the activity, the structuring was always done from outside the computer, via verbal or written instructions. It seems that grouping students according to sex [Johnson, Johnson and Stanne, 1986] and ability may affect the type and the number of interactions between team members [Hooper and Hannafin, 1991].

2. Development

The content objectives deal with the identification and the description of an animal, object or place in ESL. They are concerned with the comprehension of oral and written output. Students enter the forest in which they meet two people; a forest ranger and three campers. If they choose to meet the forest ranger, he will ask them to help him find three birds. Several strategies have been devised in order to comply with the elements put forth by the "Learning Together" method of cooperative learning. Most of the strategies aimed at fostering *positive interdependence* are included in both prototypes since these strategies would be part of virtually any learning system. All the other strategies are included only in the cooperative prototype.

Elements of "Learning Together"	Strategies (example)
positive interdependence	
ñ outcome interdependence	
goal interdependence	ñ finding the bird
reward interdependence	ñ receiving a badge if the bird is found
ñ means interdependence	
resource interdependence	ñ using pictures, notebook, glossary
role interdependence	ñ controlling the keyboard, reading
environmental interdependence	ñ working side by side at the computer
ñ interpersonal interdependence	
face-to-face promotive interactions	ñ recalling cooperative behaviors at regular intervals
individual accountability	ñ individual testing at the end of each section
interpersonal and small-group skills	ñ video segment of two groups of two students working together ñ suggesting cooperative behaviors regularly
group processing	ñ asking the team at regular intervals to evaluate its use of the social skills previously suggested

The two prototypes were developed using Toolbook 4.0. An evaluation of both prototypes has recently been conducted with four groups of two grade 5 students. This was helpful in verifying that the systems ran smoothly, that the instructions were easily understood by students and that they felt at ease with the learning systems. A second evaluation of the prototypes will be conducted in the next few weeks. This phase will be concerned with the type and quantity of interactions generated while teams are using the two learning systems and the time and number of attempts required to complete both activities. Twelve teams of two grade 5 students will take part in this phase of the evaluation process. Students will be grouped according to their sex and their ability level. Teams will be videotaped and each member will be interviewed individually during a semi-constructed interview which will immediately follow the activity at the computer. Three observers will review the videotapes using a grid to record the type and the quantity of interactions generated.

3. Conclusion

The originality of this research resides in the fact that the cooperative learning situation will be structured from within the multimedia learning system. With this qualitative research, we hope to generate hypotheses that may be useful in future research concerned with the development and use of multimedia cooperative learning systems for various learning contents and populations.

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Neuroinformatics at the Secondary and Post-Secondary Levels of Education in Lithuania

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The traditional informatics is based on the paradigm of sequentional computations to evaluate functions and soliutions. Today wider and more complex notions are necessary. The computer is to be seen as a component in a distributed, interactive systems of human, machines and other artificial and natural dynamic systems such that a paradigm of a group of communicating individuals will be more adequate. In particularly the areas of artificial intelligence and artificial neural networks are considered to be subareas of informatics. Therefore the neural computational linguistics and cognitive science are very important for engineering, communication theory and informatics as well as for education processes at the secondary and post-secondary levels. The main aim is to give knowledge for pupils and students about informatics: neural models, neural networks, parallelism in computing, learning with/out superviser and recalling, introduction in neuroinformatics, neural network software applying in different practical areas.

The main objectives of this activities are following:

a) to introduce a new area of informatics, i.e., neuroinformatics for older classes of Lithuanian secondary schools and university students as well as in other Baltic Countries;

b) to create simple with high visualization education neural network software and to promote it in practical classes of the secondary and post-secondary levels of education;

c) to use widely the computer-electronic networks for education process together with new ideas of informatics.

Reverse Engineering the Computer Graphics Animation and Multi-media Job Market: A Fine Arts Curriculum for the Digital Age

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Abstract: This short paper argues that a fine art and design education coupled with "digital literacy" is not a costly frill but rather is essential preparation for the job market shaped by the global economy. The skills of the artist and designer once thought to be marginal to business success now have taken on a new importance as an integral part of the multi-media revolution as seen in the rapid growth in computer graphics animation, interactive multi-media and design for the World Wide Web. A major study sponsored by Human Resources Development Canada entitled *Shaping Canada's Future by Design* promotes design as prerequisite to entering the marketplace and calls for significant changes in how design is taught especially in regard to the acquisition of managerial and business skills. This paper describes how the new double major in Computer Science and Fine Arts under the Digital Image/Sound Programme at Concordia University answers this challenge.

In Canada and in Quebec the "lean and mean" trend toward "downsizing" has impacted not only the corporate sector but has led to dramatic and deep cuts in funding of higher education at both the federal and provincial levels. As the baby boom generation ages universities are forced to compete for a smaller pool of potential college age customers within the borders of province and country. The "globalization" of higher education, due in part to increased mobility across borders of potential "customers" made possible by short term educational visas, distance education strategies and the exploitation of the internet for education has forced universities to compete internationally. The law of supply and demand of the new global educational marketplace along with diminishing budgets have forced universities to re-consider and revamp the traditional curricula leading in some cases to wholesale closure of programmes and departments. Students demand programmes that will get them jobs. The distinction between a university education and vocational training appropriate to the college level is blurred. At first glance programmes in fine arts and design would appear to be irrelevant to the job market and thereby vulnerable to the cost /revenue ratio meat cleaver.

The rapid growth in fields such as computer graphics animation, interactive multi-media and design for the World Wide Web is not dependent on technology alone. The role of the artist and designer must not be overlooked as an essential part of the multi-media revolution. Once thought to be marginal to business concerns the artistic qualities and design attributes of a web site or a consumer product provide the competitive edge that determines success in the marketplace. A major study sponsored by Human Resources Development Canada, entitled *Shaping Canada's Future by Design* [Price Waterhouse 1997] quotes John Tyson, Vice President Corporate Design, BNR (1994): "Design, now, is nothing less than table stakes. It is not even a competitive weapon. It is the cost of entry into the global market." This report calls for significant changes in how design is taught especially in regard to the acquisition of managerial and business skills. Art and design education coupled with "digital literacy" is not a costly frill but rather is essential to prepare graduates for the job market shaped by the global economy.

The World Wide Web is perhaps the best example of the importance of art and design. Successful web page development depends on the traditional skills of a writer, art director, graphic designer, typographer,

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illustrator/painter/photographer in combination with the newer expertise of the 2D & 3D animator, videographer, programmer, composer, sound effects designer, cognitive psychologist and a human factors engineer. In feature film production and animation the importance and the extent to which traditional fine arts skills are integrated into the digital job market can readily be seen in the job descriptions. PIXAR the makers of *Toy Story* look for computer animators who have an "All-Around Art Background: Life drawing, sculpting, painting, etc." Speilberg's DREAM WORKS ANIMATION recommends that potential candidates include "Pencil life drawings; rough sketches of animals and humans in movement; samples of personal work to show your color and design abilities." SONY PICTURES IMAGEWORKS requires the following qualifications: "Previous experience as a storyboard artist, with sketching and rendering skills on a Mac or SGI platform, using Photoshop or equivalent. Excellent client presentation and painting skills highly desirable. Bachelor's degree in Art." George Lucas' INDUSTRIAL LIGHT & MAGIC advises job seekers "to have a good educational and/or professional blend of computer knowledge and artistic studies."

In the Fall of 1997 Concordia University in Montréal begins a new programme offering the Major in Digital Image/Sound and the Fine Arts in conjunction with the new Option in Computer Science: Computer Applications. This programme includes a minor as well that provides an educational "blend of computer knowledge and artistic studies." This is not a vocational programme where a student receives accelerated application specific training over a 10 month period. This university level programme offers an in depth technical and artistic education requiring 45 credits in computer science and 45 credits of fine arts courses leading to the Bachelor of Science degree. Course requirements include software engineering, and multi-media authoring balanced by electives taken in the studio arts.

I have argued previously [Garvey 96] in regard to studio art electives and the experimental use of multi-media that the appropriate pedagogical approach calls for what might be called "user centered education." This is best achieved by the self-directed process of discovery through learning by doing combined with collaborative learning between teacher and student and between the students themselves. "In design or in fine art this means the student defines aesthetic goals and follows his or her own personal tastes and expression." The identification of the "digital arts" calls for a re-alignment and exploration of intersections across a number of disciplines previously separated by department and faculties including Commerce and Administration.

A broad based in depth "digital literacy" in a fine arts context is achievable by the careful and selective introduction and organization of a sequence of projects that combine technical and aesthetic problems over the span of three to four years leading to the Bachelor of Fine Arts. This is by necessity a multi-year interdisciplinary programme, guided by the dual principles of "learning by doing" and "user-centered education" in an environment of structured collaboration. The assertion of these intersections acknowledges the complexity of human behavior and is motivated in part by Howard Gardner 's theory of multiple intelligences where he identifies seven intelligences: linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, and the personal intelligences–intra personal [Gardner 1983]. Such a curriculum design should also take into account Donald Norman's identification of the stages of complex learning and Seymour Papert's assertion that the computer should be thought of as a material with which one constructs. "The final goal is to encourage students to learn how to learn, how to teach themselves to analyze and define problems and how to find solutions through self created tools." [Garvey 1995]

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THE ROLE OF EDUCATIONAL TECHNOLOGY IN THE UKRAINE AND THE PHILIPPINES: TWO CASE STUDIES

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Abstract: This paper describes how Metropolitan State College of Denver is using technology in working with institutions of higher education in the Ukraine and the Philippines. The examples describe two different environments in working toward effective use of educational and distance learning technologies.

Global education that prepares our students to live and work in a worldwide community has long been the promise of distance and educational technology. Until recently, however, that promise languished because of an inadequate international technological infrastructure and a lack of understanding and often reluctance on the part of educators to use that technology. Bailey and Cotlar (1994) write, "Resistance to pedagogical changes utilizing technology is often due to faculty and administrator reluctance to explore new techniques out of a fear of change in general or the technology in particular." This resistance is slowly lessening, and the widespread implementation of the Internet is resolving technological issues. Recently, faculty and administration at Metropolitan State College of Denver (MSCD) have had experience in serving remote and developing areas of the world from policy study and development and practical instructional applications.

MSCD, located in Colorado, is the largest public undergraduate urban institution in the U.S. The college has made a significant commitment to the teaching/learning paradigm and to the use of appropriate technology to increase access and student learning. MSCD recognizes the important role of internationalism. The authors report on how technology is allowing MSCD students to interact with their counterparts in Crimea, Ukraine; and how it is being used in the Philippines to help educators think and act strategically in the development and implementation of policies to meet defined goals.

Ukraine

Since 1994, faculty from MSCD and a partner institution have been working with Simferopal State University in Crimea, Ukraine to provide opportunities for students in both countries. More than 50 Ukrainian students and 200 U.S. students have participated in the project. Simferopal State University is located in Simferopal, a major population center of Crimea, Ukraine. The university serves some 5,500 undergraduate and graduate students and is well known for its curriculum in theoretical physics. Progress to date includes:

--Online courses--Ukrainian students have completed some of the online courses currently being offered by the U.S. schools. If space exists in a class, and with instructor permission, the students are allowed to participate. Ukrainian students are often paired with US students to work on course projects. In addition, they are usually included in e-mail groups to discuss course readings and assignments.

--Course resources--researchers have long espoused the availability of resource people located throughout the world as a major advantage of distance education (McComb, 1994). Ukrainian students not participating in formal online courses, as well as their professors and advisors, are often available as

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primary resources to US students. Input from the Ukrainian students is valuable in virtually all courses, not just those dealing with Ukraine and Eastern Europe.

Ukrainian students in this project have access to only one Internet e-mail account, and messages from MSCD instructors and students are printed and distributed individually. Despite this limitation, the system has been remarkably reliable with very few messages being lost during a two year period. More restricting is the fact that the students have access only to e-mail--other Internet functions, including access to the World Wide Web, are not yet available. Students and instructors at both institutions have been remarkably clever in encoding binary files into e-mail messages, but the true potential of this project will not be realized until other Internet functions become usable.

The Philippines

The Philippines, a developing country, has a goal of being internationally competitive in the next century. The country's leadership recognizes the importance of global connectivity. The Commission on Higher Education CHED) is a newly created national agency responsible for the approximately 1,200 public and private higher education institutions in the country. Over the past two years, the Commission has been developing a long term development plan for higher education in the Philippines.

The needs and challenges are many. Clearly, technology is one. Technology can help advance the country's goal of global competitiveness; technology can assist in developing a national infrastructure for data collection; technology can build and enhance research capacity so needed in a developing country; technology can enhance learning and teaching and provide opportunities for students and faculty throughout the world to interact and solve real world problems; and technology can improve access. Technology relates directly to each of the four priorities of the Commission: quality and excellence; relevance and responsiveness; access and equity; and efficiency and effectiveness.

While the Commission recognizes the importance of technology, the main office in Manila has no connectivity. Fourteen regional offices report to the central office; none have computer connectivity. These offices oversee hundreds of institutions and thousands of students, yet there is no database from which to work.

Yet, some of the private institutions and a few of the public institutions have the infrastructure in place and are competitive. Internet access is not a common feature either at CHED or at many of the institutions throughout the Philippines. Thus, key issues relate to resources for infrastructure, equipment, and faculty and staff training in order to provide an environment for higher education to adequately prepare students for the global market.

Conclusion

These two examples describe two different environments in two developing countries, one from a practical level and one from a policy level in working toward effective use of educational and distance learning technologies. Initiatives like these are only the beginning. Dubois (1996) writes "For years the distance learning community has patiently awaited a global education mandate which advocates multidisciplinary learning, global awareness, foreign area and multicultural studies...After all these years, we now have a sense of urgency, a curricular focus, and a national initiative." As more and more educators work towards true global education, we may begin to realize the dream of Marshall McLuhan for a "global village."

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Learning About Learning From *Stat Lady*

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Abstract: The purpose of this presentation is to report some of the results from our efforts to come to a better understanding of the learning that occurs while subjects are using a particular piece of instructional software. Relying on the dense and rich data available through verbal protocol analysis has led to some interesting insights over the course of this project. We describe these results and stress the importance of exactly this sort of fine-grained analysis of learning behavior for improving the positive impact of technology in educational settings.

This paper summarizes results from the first step in a multi-stage project to test the applicability of the ACT-R theory [Anderson 1993] as a foundation for modeling cognitive skill acquisition with a tutoring system *not* developed by CMU's Advanced Computer Tutoring Group [Anderson, Corbett, Koedinger & Pelletier 1995]. It is the first time such an effort has been undertaken.

The tutor chosen for this project is the *Data Organization and Plotting Module* [Shute & Gluck 1994] of the *Stat Lady Descriptive Statistics Tutor*, developed at Armstrong Laboratory's TRAIN Lab. It is designed primarily as a cognitive modeling research platform [Shute 1995], but has also demonstrated real value as educational software that results in significant learning gains [Shute & Gluck 1995].

The first step in developing a cognitive model of how students learn from *Stat Lady* was to study student-tutor interaction at a fine level of detail. We ran four verbal protocol subjects at CMU through the *Stat Lady* pretest, tutor, and posttest. These subjects provided concurrent talk-aloud protocols [Ericsson & Simon 1990] the entire time, which averaged a little more than 8 hours of participation per subject. Subjects were prompted to talk aloud at all times, resulting in dense verbal data on their interactions with the tutoring system. Due to the impracticality of analyzing the entirety of the verbal data, we identified the easiest and hardest sections of the tutor and focused the protocol analysis there. Those two sections comprise 40% of the time spent on the tutor, and are the 1st and 3rd of five sections. For reliability, a second experimenter independently segmented and coded half of each subject's protocols. Perfect coding agreement was reached on 89.8% of 3,266 protocol segments. Codes for the remaining segments were easily agreed upon after brief discussion.

As is the case in any tutor development project, various implicit and explicit assumptions guided the creation of *Stat Lady*. Attending to subjects' learning and performance behaviors at such a fine level of detail with this rich set of verbal data has allowed us the opportunity to examine how students actually use the tutor, as well as what and when they really learn from it. In other words, we have put some of the design assumptions to the test.

Testing the Design Assumptions

The tutor is sub-divided into five main topic areas, each one building to some degree on the material covered in the earlier areas. The pedagogical pattern within each topic area is (1) an instruction section which presents relevant material and gives the learner an initial chance to apply that knowledge in problem solving, and (2) a set of scenarios which test the requisite skills. The student chooses one scenario at a time from a set of five, based on personal interest (e.g., football, amusement park). Each scenario begins with a story that establishes a "context" and related goal, the pursuit of which requires the student to answer questions and perform tasks relevant to the curriculum objectives. Responses during all problem solving activities are accompanied by positive and negative feedback in both text and sound file formats. Rather than stoically functional in character, some effort was invested in developing feedback that reflected the personality of *Stat Lady*, which is perhaps best described as "sassy." The assumption in creating the elaborate feedback and detailed contexts was that this would draw students into and keep them involved with the learning process. In fact, there is evidence in the verbal protocols that this is the case. Almost without exception, the participants in this study read the context portions of each scenario very carefully, often reflecting aloud on the plot or premise of the scenario along the way. This is despite the fact that knowledge of the context is not absolutely essential for successful completion of the scenario and it is possible to skip right past it without much more than a cursory glance. Second, there are examples throughout the protocols of students reacting to the feedback sound files, sort of "talking back" to the tutor, as if receiving feedback from a human. This suggests that those sound files may help maintain a higher level of student involvement in the tutorial process, but this remains an empirical issue.

A second significant assumption influencing the design of the tutor, and which is consistent with contemporary learning theory, is the assumption that most of the knowledge and skill learning comes with opportunities to practice and apply those skills. In the case of this tutor, the assumption was that those opportunities would come primarily during the scenarios. Our protocols indicate that significant learning events often are taking place well before the scenarios - in the instruction section, and sometimes even in the pretest. Information like this is important to know for those interested in maximizing efficiency via student modeling.

A final design assumption was that providing a certain degree of redundancy in the instructions for working through problems and in the feedback (note that they receive both auditory and text feedback) would facilitate more effective and efficient learning by reducing the need for search across the screen. Thus, if a subject is not sure what to do next, it is often the case that the directions can be found in more than one location on the screen. Verbalization trends from our protocol subjects suggest a sensitivity to which portions of the screen are important for problem solving at any particular time. Less important (mostly redundant) sections of the interface are attended to less and less with practice. This indicates a facility for acquiring knowledge of the structure of the learning environment, and that students become sensitive to this structure and adapt their behavior accordingly.

The Take-Home Message

What lessons might other designers of educational research software extract from these conclusions? First, consider interesting auditory feedback and problem solving contexts as means of maintaining student involvement in the learning process. Second, allow for the possibility of early learning events, especially when designing tutors that will include student modeling capabilities. Third, it may be important to build cognitive models of not only the learning of the specific curriculum objectives the tutor is designed to teach, but also the acquisition of environment/interface knowledge. Finally, and most importantly, we strongly encourage developers of instructional software to invest some time in this sort of close analysis of student learning with their systems. As evidenced here, there is a very real potential for interesting insights.

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Peitho: a Support Tool for Learning Critical Thinking

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Abstract: This paper describes a software tool called Peitho that supports critical thinking and, particularly, the learning of critical thinking skills. Peitho uses a rhetorical rather than logical model to represent knowledge about critical thinking. While this model is flexible and broadly applicable, it is shallow in that the meaning of the content of an argument is only represented in text overlaid on rhetorical structures. This apparent step backward from knowledge representation shifts the burden of domain expertise to the user. However, Peitho, as rhetorical expert, can still offer advice on analyzing content. Applying Peitho to particular models used in teaching critical thinking has revealed weaknesses in those models and has lead to a taxonomy of features for judging particular instructional models of critical thinking.

Theoretical Model

Peitho is a generic argument design system. Within it, templates are created to fit a specific domain, such as law or science, or to match the strategies of a particular textbook on critical thinking. These templates are then used to construct or critique arguments. As described later, the creation of Peitho templates is a rigorous and revealing test of models of critical thinking.

Critical thinking is the skill of rational persuasion. It is the ability to frame an argument to persuade others and the ability to decide how much to be persuaded by the argument made by someone else. As such, critical thinking is more than just logic because one can persuade where formal proof is not possible. Conversely, critical thinking is less than rhetoric with its three modes of persuasion: *logos*, *ethos* and *pathos*. Critical thinking comprises only the rationality of logos, rejecting the appeal to emotion of pathos and the appeal to authority of ethos.

How then to represent the reasoning process in a program to support the learning of critical thinking? Critical thinking is not restricted to formally constructed domains so the choice of a representation system must consider this constraint. Logic *has* been extended to embrace the incomplete and inconsistent information which is characteristic of common sense reasoning but the resulting constructs are not very powerful and not very intuitive. There are also credible alternative representations like neural networks and genetic algorithms which handle messier problems quite well. Unfortunately, these non-symbolic systems do not provide much meaningful structure from which a human observer can learn.

Rhetorical models retain the symbolic representation of logic and are more accommodating of incomplete and inconsistent information. Indeed, a rhetorical argument is typically presented in a situation of dialogue in the full expectation that it will be challenged. Such models are robust and broadly applicable. Most texts on reasoning and critical thinking include a model of this type, identified as 'informal reasoning.'

The major drawback of these informal models as a basis for software is that they are representationally powerful but procedurally weak: they can describe argumentation but they can't 'do' argumentation the way logic or neural nets can. In spite of this, Peitho was designed as a rhetorical model and turned out to have some procedural power.

A second problem with rhetorical models is that so many exist. Virtually every author on critical thinking develops a new model with unique features and emphasis. Even prominent thinkers in rhetoric, such as Toulmin [Toulmin et al. 1984], are widely acknowledged but not applied. No definitive model has emerged, so Peitho has been designed as a generic lower level environment in which particular models of reasoning can be constructed as templates.

System design

The Peitho environment is simple. An **argument** is a collection of **statements**, one of which is a **claim**. The rest of the statements are **facts** which support the claim. With the argument as justification, the claim becomes a fact to use in other arguments. Every fact should be established, either by a supporting argument or by an external **reference**.

A collection of arguments connected by claims-become-facts is a **chain of reasoning**. The claim of the final argument, called the **major claim**, presumably is the statement the arguer wishes to establish.

On this generic base, particular models of reasoning are constructed by specifying (i) what kinds of external reference are acceptable and (ii) what the internal structure of an argument can look like. For example, Toulmin's model of argument includes, in addition to a claim, particular fact types called *backing, warrant, grounds* and *rebuttal*. (Toulmin's *modality* is a property, not a fact.)

Once the reference types and argument strategies of a particular reasoning model have been incorporated - by a course author or instructor in an educational setting - the system is ready to apply to critical thinking in some domain of knowledge. This is the student activity in an educational setting.

To support the arguer, the structural model is complemented by a process model defining three activities, (i) **information gathering**: statements are added to the set, (ii) **organization**: the statements are assembled into arguments to form a chain of reasoning, and (iii) **analysis**: the reasoning is critically examined for structural and semantic validity. The user shifts easily but explicitly among the activities.

At the analysis stage, Peitho supports the user in critiquing the chain of reasoning. First, it does automated analysis based on the generic structure. For example, circular reasoning can be identified as a cycle in the chain of reasoning graph. Second, it includes an advising feature inspired by the observations of writing instructors that, even without domain knowledge, they can successfully advise learners. [e.g., LeBlanc 1993] The generic structure contains some advice, for example guidance on examining individual statements for ambiguity. More specific advice about particular argument templates is provided by the template creator. Advice is context sensitive: the learner is reminded of requirements at a particular point and guided to evaluate statements and structures by applying her own domain knowledge.

A payoff - Rigour in Models of Critical Thinking

Peitho currently exists as a prototype system in Visual Basic. The instructor of a philosophy course on *straight thinking and argument* has used the software to construct templates and confirmed that it successfully captures the particular approach to critical thinking which he uses. The system has also been used by experienced critical thinkers to develop and criticize arguments but has not yet been tested with learners as the user interface is being improved.

Nonetheless, Peitho has already proved its usefulness in an unforeseen way. During development, many models of critical thinking were examined and had influence on the design but the fact that none stood out as exemplary led to the generic low level model that was finally adopted. To test the software, the models were implemented as Peitho templates. This was a rigourous test that exposed the strengths and weaknesses of each. Some models contained incorrect features but most just suffered from an imbalance of emphasis - authors stressed aspects they considered important and ignored others. From this experience, we propose some features essential to a complete model of critical thinking for instructional use:

- Does the model allow for differences among domains of discourse?
- Does the model define the dependence of arguments on backing from the domain?
- Does the model define properties of statements or atomic units of information?
- Does the model define both structures of argument and processes of argumentation?
- Does the model account for one step arguments and extended chains of reasoning?
- Does the model decompose in a learnable manner?

The CD-ROM version of this paper contains more detail on Peitho and the meta-model of critical thinking.

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Educational Analog/Digital Video Networks

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Abstract: In this paper, we are going to consider a parallel analog network which is dedicated to video and which works together with the regular digital network. This approach can be very efficient for those applications which require the distribution of full- screen real-time motion video to many users simultaneously. Video distribution via separate analog network will not affect the digital part of the network and, hence, can be used for different real-time class activities without slowing down data processing through the digital media. We used ADViNet for all traditional classroom activities: lectures, tutorials, group work, and class monitoring. A specially developed adaptive feature of the ADViNet allowed us to provide very efficient class monitoring during drills as well as real-time help to the students who have difficulties.

Introduction

Computer networks and data communication technology have had a profound impact on education. Networks can dramatically improve the teaching and leaning environment in the classroom [Ahamed 97]. Different educational network-based systems can benefit from presenting full-screen real-time motion video to many users simultaneously. Desktop video is a technology struggling to cope with two major challenges in the transmission and management of digital audiovisual data: the large amount of data involved and the time-dependent structure of the information. The first challenge requires large storage capacity and a high rate of data transmission. To meet the second challenge video information must be delivered on time. Video is known as delay-sensitive payload [Goldman 95]. A typical LAN is inefficient when transmitting large continuous blocks of data. When the network becomes busy, all real-time data including video will be slowed down.

A variety of strategies can be used to improve video distribution in LANs ["The Challenges of Networking Video Applications" 96]. Among them are: the replacement of bottleneck equipment and protocols, the installation of faster transmitting media, a change of the topology of the network which better fits the purpose of video distribution (changing from bus to star topology), the use of compression, and the installation of parallel equipment dedicated to video distribution. In this paper, we are going to consider a parallel analog network which is dedicated to video and which works together with the regular digital network. This approach can be very efficient for those applications which require the distribution of full- screen real-time motion video to many users simultaneously (broadcasting or multicasting). Video distribution via separate analog network will not affect the digital part of the network and, hence, can be used for different real-time class activities without slowing down data processing through the digital media.

Hybrid Analog/Digital Video Networks (ADViNet).

The typical physical architecture of ADViNet includes two communication media: digital and analog. The digital medium is used by the regular digital network according to its type and topology. The analog medium combines a VGA bus with several additional control lines. All the monitors in the LAN are connected to this bus by special switches. Each monitor can work in one of the two states: local - when the user can work independently with his\her workstation; and remote - when the monitor is connected to a remote source of video information. The analog bus is controlled centrally from the master station We developed a logical architecture of the ADViNet. On the logical level, any station in the ADViNet can be active; for a limited time, any station can have the status of the master station in the control of the analog medium. An ADViNet with this architecture is able to support not only single presentations, but also different kinds of network jobs where all the participants may be active. These activities and group work can be held concurrently with other network actions and will not slow them down. Any real-time graphical information including motion video can be presented in the full-screen format. The analog medium is controlled through the digital part of the network. In order to move to a decentralized model, in which any station (under certain conditions) can control an analog network, a two-layer ADViNet management protocol was developed. The physical layer provides a set of the necessary protocol commands to control the analog part of the video network. These commands are hardware oriented. They depend on the type of the hardware and, among others, include all the commands that can be issued to the analog network in the manual control mode. All the commands on the physical layer can be issued only from the master station. The main function of this layer is to support the programming control of the analog video network from the master station. Introducing the physical layer of the ADViNet management protocol does not change the architecture of the video network: it is still a network with centralized control.

The logical layer of the ADViNet protocol does not depend on hardware. This layer allows us to transform a video network with centralized control to a decentralized model. Any workstation which intends to control a video network has to open a session. To accomplish this task, the workstation should send an appropriate request to the master station. If the session can be opened, the parameters are negotiated. For all communications on the logical layer, both a workstation and the master station use a regular digital network.

Network management software includes the following functions: session establishment and control, administration, analog network monitoring, security, statistical analysis and reports.

In a multicast mode, the video images are transmitted from one station to a group of stations. Very often this group cannot be defined in advance. The set of nodes included in the group can even be changed during the session. As a consequence, the analog video network is capable of reconfiguration on the fly to meet changing needs. For this, we included extra computational capabilities in the ADViNet protocol. Specially developed protocol primitives enable a primary station to have dynamic control over the states of the secondary stations. This was done by providing the computation and analysis of several functions that depend on students' performance and define whether or not to include a student station into the group. Such a video network will change its configuration dynamically, as needed, in response to random external events.

Teaching in the ADViNet Environment.

We used ADViNet for all traditional classroom activities: lectures, tutorials, group work, and class monitoring. On the hardware level, the network is based on Computer Video Web (ComWeb) from ComWeb Technology Group, Inc ["Computer Video Web" 96]. ComWeb is a pure hardware system which provides physical connections (36 workstations and one master station in our classroom) and the ability to control the video network manually (by using the Control Panel). The main system hub has a special port that enables the master station to control a video network remotely by using a serial interface.

One of the goals of this network is to enable the instructor to analyze the students' performance and provide them help in real time. A specially developed adaptive feature of the ADViNet allows to provide very efficient class monitoring during drills as well as real-time help to the students who have difficulties. For this purpose, the master station gathers and analyzes the information about the current state of any student's station. This information shows each student's performance. Based on the analysis, the master station dynamically changes the configuration of the ADViNet: new nodes can be added to the monitored group, and others can be removed. The instructor can always observe only those students who are behind the schedule and submit them real-time help by taking control over their computers.

From our experience, we can say that video networks prove to be very helpful in the classroom and have considerable influence on the teaching methodology.

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Proficiency and Practice with Observation: A Child Development Theory and Methods Tool

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Abstract

The Child Development Observation Resource (CDOR1) CD-ROM provides a learning environment for practice and experience in observation methods for students studying education, psychology, and related professional courses. Observational analysis requires theoretical understanding and practice for the development of the skills of coding. The CDOR1 multi-media environment is designed to afford students the opportunity to learn about the benefits and constraints of observational methods and to engage in practice through viewing child development video clips, examining key texts, applying standard coding schemes, and developing new coding schemes. CDOR1 is intended to be suitable for use within a structured course of study, or as a stand-alone package. Evaluations conducted 'in-the-field' will further guide this work-in-progress.

1. Introduction

This paper describes an interactive multimedia package, Child Development Observation Resource (CDOR1), for learning *about* observational methods and for learning *to do* observational analysis, which is being developed at the Open University. The possibilities of using new technology to provide environments to foster the advantages of learning by doing (such as the enactment effect and the generation effect) has been well recognised (Hammond, 1993); it is intended that this package nurtures such learning. In its current form CDOR1 contains a wide range of documentary materials about child development including video of child development experiments, and video of children alone and interacting in groups. The package is particularly applicable to students of psychology, education, and social work studies.

The package aims to:

- provide training in methods of observing, coding and analysing human behaviour in natural and experimental settings
- assist students in linking research evidence with practice
- demonstrate the methods and results of key experiments in developmental psychology and other areas of social science
- give access to leading researchers' verbal descriptions of their research, its methods and theoretical implications

2. Structure of CDOR1

The design of CDOR1 is intended to be flexible enough to enable an academic teacher to draw upon the resources available in the application freely, using video, texts, coding tools, literature, and lecture sources as he or she considers best, to fit the purpose of their teaching. In addition the package is designed to support individuals who

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are working alone and encountering such material for the first time. The application provides a tutorial level of provision, providing guidance through the media so that understanding of important concepts, such as the concept of reliability, is developed. As well as providing structured pathways, there is also the opportunity for students new to this methodology to simply view a piece of video, and to explore the images in a theoretically naive way through experimenting with the coding tools available within the package.

2.1 Training in Observational Analysis

(i) Linking Research with Practical Skill

The application contains discussions by researchers of key concepts and issues in observation and child development. It is intended that this engagement with multiple perspectives regarding observation will foster a deeper understanding (Duffy & Knuth, 1990). The package also contains a glossary of key terms and related information, as well as papers and abstracts detailing the reasoning behind the adoption of particular observation methods in the arena of child development. One option available to the students is to use the materials offered to make an informed decision regarding which coding scheme to choose, or to use the arguments advanced in key papers to construct a coding scheme of their own.

(ii) Coding Capabilities and Analysis Package

As well as allowing students to set up their own coding schemes the application contains well used and referenced coding schemes from child development studies for use by students in analysis of the video material. Students will be able to check their coding reliability against results available from expert coding.

(iii) Key Experiments

Key experiments with accompanying commentary are provided within the package. These are linked to research papers describing these studies and serve to highlight the issues and implications for observation that arise from such work.

3. Evaluation

The development of CDOR1 is currently in progress. By the summer of 1997 a beta test version of the package will be ready for evaluation within real learning contexts. It is intended that the initial context embedded evaluations will take place at Open University Summer Schools (residential components of distance learning courses) and within conventional university courses.

'Learning by doing' using new technology affords new opportunities for students of psychology and education. We anticipate that using multimedia to learn about the methods of research and the practice of professional groups will facilitate active and profitable learning for students of these disciplines.

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Business Skills Online: Strategies for the Electronic Environment

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Abstract: This session will showcase the Business Skills Online project and the technologies and strategies for teaching and learning. The Business Skills Online project migrates computer conferencing, print-based course materials to the World Wide Web (WWW). Students receive tutorial support from teachers at a distance through the use of computer technologies. In 1996-97 the Business Skills Online project is testing new ways to speed up communication between teachers and students; provide peer support and, where appropriate, achieve faster turn-around of assignments and projects. The project gives students opportunities to discover business careers in newly emerging industries and in industries often unexplored by rural remote students This session will showcase the Business Skills Online project and the technologies and strategies it utilizes for teaching and learning.

Business Skills Online: Strategies for the Electronic Environment

The Business Skills Online project is leading the way in using information technology to provide enhanced education for distance learners in British Columbia. The project offers the Open College's Business Skills courses to students in schools, learning centres, and at home.

The Open College is a service of the Open Learning Agency (OLA). Through the Open College and Open University, OLA provides accredited distance educaton programs through a variety of media.

The core of the Business Skills Online project is the mediation strategy for enhancing student success. This model involves tutor to student and tutor to group relationships as well as student to student and student to group relationships. The tutor is the content expert and instructor for a specific course and works with students from a variety of distant locations in the province of B.C.

The tutor supports students at the sites, assisting with course issues, helping with the technology if applicable, dealing with administrative issues, and providing on-going counseling. The students engage in learning activities with tutors and peers (local and distant) through computer communications technologies. They are responsible for completing their course assignments and interacting, through computer conferencing and the WWW, with tutors and other students on a regular basis. The OLA has proven that this directed independent learning model increases student completion and success rates over the duration of the project.

The Business Skills Online project engages students in learning activities directly related to the rapidly changing and competitive business markets. This program is devoted to developing solid business understanding utilizing technology, innovative communications media, and cutting edge course delivery methods.

The Open Learning Agency is committed to providing exemplary, alternative educational programs and will utilize many of the technologies, learning models, and program development strategies of Business Skills Online project to ensure success for all B.C. learners.

First Nations Distance Education: a Collaborative Approach with the First Nations of B.C. and the Open Learning Agency

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Abstract: This session will showcase the First Nations Computer Conferencing project and the technologies and strategies for teaching and learning at a distance in cooperation with the Open Learning Agency (OLA). The Agency's mandate is to provide and deliver open learning opportunities in the province of B.C. We are committed to serving as a model of accessibility, opportunity, and flexibility in education. The OLA is using multi-media technology to expand its services. The First Nations Computer Conferencing project integrates computer conferencing, audio conferencing, and print-based course materials to facilitate the accomplishment of three primary tasks: course materials adaptations; professional development for instructors; and creating a virtual community for tutors and students.

First Nations Distance Education: a Collaborative Approach with the First Nations of B.C. and the Open Learning Agency

The First Nations Computer Conferencing project is developing methods of using existing technology to provide enhanced education for distance learners in First Nation educational centres. The first phase of this project connects six First Nation educational centres located throughout the province to the Open Learning Agency's Openet computer conferencing system . Future phases of the project include offering this program to other First Nation educational centres and the migration of course content to the World Wide Web.

Phase I

Course Materials Adaptations

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Planning sessions were held with First Nations representatives to address the issue of adapting existing course materials for use in First Nations Learning Centres. Some of the items discussed were the importance that courses and materials be specific to learning centres' needs (e.g. resource management, fisheries courses). The development of aboriginal studies course materials for specific linguistic groups and adapting course material to reflect cultural needs.

Professional Development for Instructors

Through the computer conferencing system, First Nations Learning Centres are linked to the Open Learning Agency and to each other to provide a forum for sharing of ideas and solving of administrative and student issues. Professional development for instructors and tutors was one of the main focuses.

Of the key concerns voiced by First Nation Centres, the sense of frustration in the development, maintenance and support of their programs in isolation stood out. To address this issue the following items were identified as areas to base the project on:

- assignment marking - peer exception
- interaction with others for isolated instructors—share impressions of courses
- sharing experiences, problem solving, course related and matters of attendance
- counseling re catastrophic events in lives of students & community
- administrative models for setting up Adult Basic Education programs for increasing population
- coordinators ability to tap into experience of other centres in setting up and administering programs
- ongoing training for summer/seasonal replacements
- course counseling for students
- contact between First Nations instructors and regular tutors
  - interested in establishing links with non-native education centres and tutors.
- administration, promotional (student recruitment) strategies shared between centres

Virtual Community for Tutors and Students

The planning participants identified many instances where computer conferencing could be used to deliver courses to students, to link student bodies together, to enable more cost effective delivery of course for isolated students and to provide a sense of belonging to community of isolated students and tutors or groups of students.

This project enables the diverse First Nations of B.C. to form a sense of culture and community in a unique model of distance education delivered through their own learning centres.

Return on Investment (ROI) for Electronic Performance Support Systems: A Case Study

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Abstract: Return on Investment (ROI) is defined, distinguished from Cost Benefit Analysis (CBA), and the need for ROI discussed. ROI for training versus ROI for Performance Support Systems (PSSs) is discussed as well. ROI is framed in a model developed by Kirkpatrick [Phillips 1996a], and expanded by Phillips. Several different PSSs will be used to illustrate the nature of such systems, with particular emphasis on the one supporting the Financial Management System of the Office of Veterans Affairs.

Return on Investment (ROI) is a financial measure of the value to the bottom line, of a particular investment, in this case training or a performance support system. Why is ROI needed? With a growing concern for the "bottom line", and as a potential consequence of a decreasing budget for training and other "non-direct" expenditures, return on investment (ROI) becomes an important topic in business, industry, and, more recently, government. Personnel most closely involved in human resources activities know that their work is valuable to an organization, but are not accustomed to quantifying such value in terms understandable and meaningful in today's economic climate. Developing ROI methodology provides the information needed to determine the value to the bottom line of such non-direct expenditures. This information can be used to fine tune an organization by distinguishing between services that enhance and those that detract from overall profit. Consequently, application of ROI methodology is not only a necessity for training and other human resources personnel, but also a valuable tool for budgetary decision-making in any organization. [Phillips 1996a] In some situations it may become a critical survival strategy.

Concurrently, there is growing interest in performance support systems (PSS) as a means to increase performance while decreasing training costs. Traditionally, training has been performed in a classroom or other setting external to the actual workplace. Performance support systems (PSS), on the other hand, provide assistance or training "just in time" and as needed in the workplace. PSSs have advantages over traditional training not only by providing training only when and where it is needed, but also through giving the user immediate feedback on his or her performance, distributing the training over time in the work situation and environment.

Typically, higher PSS costs are incurred during initial development. However, delivery costs are lower than for traditional training and are more difficult to track. Thus the initial ROI for a PSS is lower than the initial return for traditional training, since the learning is done "on the job". Consequently, the return on investment for a PSS increases the longer the lifetime of the PSS. However, many costs associated with traditional training, such as classroom space and travel, are eliminated with a PSS.

While the purpose of training is to enhance performance, just-in-time performance support systems are under some conditions being promoted as a better and more efficient platform for both education and performance enhancement than traditional training for many job activities, especially for those involving a computer. PSSs, however, are not a "magic bullet". There must be significant potential for performance improvement to gain significant ROI for either training or PSSs. Measuring ROI to judge the value of a PSS is just as important and needed as measuring ROI of a training program. How to perform an ROI and whether the ROI from the specific PSS being studied for this investigation is significant or not were the two major research questions of this study.

Measuring return on investment for PSSs is difficult, in that the effects often are not directly measurable. The use of control groups, one commonly used method of determining ROI for training, is not practical in most cases of PSS implementation because the consequent degraded performance for the employees not having benefit of the PSS would be detrimental to production and to morale. Additionally, there are many intangible benefits to both training and PSS. It is practically impossible to quantify the benefits of increased job satisfaction, organizational commitment, improved teamwork, customer service, and reduced stress. These qualitative benefits do have value and can be measured through survey instruments, even though that value may not be quantifiable in monetary terms.

Phillips [1996a] proposes a formula for calculating return on investment that differs from that commonly used to calculate a cost/benefit ratio. A cost/benefit ratio is calculated by dividing program benefits by program costs. Phillips proposes calculating ROI by dividing net program benefits by program costs, thereby subtracting out the cost of the program from the numerator before obtaining the final calculation.

In 1996, the U.S. Department of Veterans Affairs (VA) began a process of reorganization of education and training for employees throughout VA. In anticipation of such changes and of the paradigm shift from traditional education and training to *just-in-time*, *just-enough*, *on-demand* performance support, staff at VA's Birmingham Education Center conceptualized a new mental model, PETS—Performance, Education & Training Support—and a began series of proof-of-concept projects for developing, demonstrating, and assessing application of the model to VA's needs.

One initial proof-of-concept project addressed a critical training and performance problem for a system-wide, financial management system (FMS). The performance support solution provided the user with field prompts which appeared as clickable buttons. When clicked, a button activated a script, launching a variety of performance support assistance including standard MS Help, frequently asked questions, a glossary of terms, code tables, examples, and procedural guidance and, via a floating *flashpad*, access to the voluminous *FMS Procedural Guide*, online as converted web document.

The PSSs under development for the VA take many forms and are used in a variety of settings. Also, they continue to be refined based on experience using a rapid prototyping approach wherein incremental changes are made almost on a daily basis. Accordingly, we will illustrate several different PSSs at the Ed-Media conference, with particular emphasis on the one described above for which the ROI study is being done. Also to be described are the specific ROI model that has been developed along with its accompanying data collection tools. The model and tools are themselves being incorporated into a PSS that will be illustrated.

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Attractiveness in Video Game

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Abstract: This paper describes extracting attractiveness from video games in order to create attractive computer based educational system. We embed the game's attractiveness elements into educational system. For embedding the game's attractiveness, we classify the game's attractiveness based on the needed technique. This classification indicates the limitation of attractiveness realized by standard engineering techniques.

1 Introduction

To create attractive computer based educational system is important issue. Introducing game elements into educational system is well-known as one of representative approaches and therefore it is not a new idea itself. However, our idea has other new points, specially in extracting attractiveness from video games[Hayashi etal]. Video games are very popular to young people and they are known as a representative computer application with attractive elements and familiarity. The main point of our idea is to embed the attractiveness but not to implement game into educational system. Some existing educational systems include game internally. Our approach aims to provide a general way to realize an attractive system using the attractiveness elements.

2 Video game

We classified video game into eight categories; shooting game, action game, simulation game, puzzle game, adventure game, RPG (Role Playing Game), ARPG (Action RPG) and bodily sensation game.

In shooting game, players need eye sight to capture active objects and also faster reflex. If the player continues to avoid enemy attack and conversely destroys the enemies, s/he complete the game. In many cases, the player becomes a pilot of fighter and fights with many enemies in the game world such as space. Players feel the game's attractiveness in the battle. In the action game, the player can fight by body actions of her/his character. The typical world of some action games is in fantasy. This causes girls to play the action game for their own pleasure. S/he knocks down the enemy characters by her/his character operations. Simulation game are classified into types of war, board game and sports. The war type of simulation game simulates various wars and the game player behaves as a commander or samurai master. The board type and sports type of simulation game simulate various games played by some members. The computer simulates the behavior of other players except of the human player. Puzzle game requires logical thought from the game player. The player with a good logical thought is good at playing. There are some puzzle games wherein the player's thinking time is reduced and therefore s/he can play by a reflex action. There are some games which become dull after the player has completed them. Adventure game are classified into detective type and character type. The objective of the detective type is to solve some questions by inference. In the character type of adventure game, the player behaves as a character of a TV animation and so on. The attractiveness is to have experience of original world such as TV animation. The typical feature of adventure games is the quality of their scenarios, prepared by the game writer. The typical feature of RPG is growing up characters. The feature attracts the player to RPG. The characters generally grow up by experience points from the battles and the completing of quests. The player plays the game by an indirect battle simulation. ARPG is a hybrid game between RPG and action games. ARPG adopts the real time battle by direct manipulation. The player needs being skillful with her/his fingers. There are also many visual effects in the battle scene in ARPG and these effects attract the game player. Bodily sensation game includes special machine body for players to play in more real environment.

3 Game's attractiveness

We extracted various kinds of attractiveness in video games through a questionnaire. Although most of the attractiveness elements exist in traditional games without computers, high software control by the video game machine makes game's attractiveness more amusing and charming.

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The element of time restriction is used in many video games because computer games can easily handle the time function by using the inner timer of the computer. The time restriction excites the game player and s/he wants the excitement from the time restriction. Level up is the typical feature of RPGs and ARPGs. The game characters in these games are operated by the game player and they become to be strong by acquiring "experimental point". The characters can get the point by beating monsters or completing quests. The amount of experimental point is essential parameter for deciding the character's level. The game player enjoys bringing up her/his characters in the game's world. Stage clearing is the typical task of shooting games and action games. The world of recent shooting game is generally separated into some sub worlds called "stages." Clearing stage excites the game player so it is important as an attractiveness element of shooting game. The element of puzzle is often embedded in various kinds of games. The game player enjoys finding the answer to a puzzle in trial and error, so interesting puzzle games attract the game player a long time. Story is an important element of adventure games, as well as in RPG and ARPG. If the story is not exciting, the game player feels that the game is a dull game. The story is the essential point of attractiveness in many games. The attractiveness of game relates strongly with the story. Competition is very popular style adopted by many games. Two or more players can play in the competitive game in traditional games without computers. On the other hand, video game simulates some necessary players for game progress. Therefore the game player can play a competitive game alone. However, the attractiveness of competition is not in playing game alone but in fighting with other players in the game. Sound and graphics are the representative features of video games by using multimedia techniques. They are also extracted as the elements of attractiveness from all game categories. This fact suggests that sound and graphic are general attractiveness elements of video game. The game player feels attractiveness from beautiful sounds and colorful graphics.

4 Which technique realizes attractiveness ?

For embedding the game's attractiveness into an educational system, we have classified the game's attractiveness into three groups, based on the needed technique; multimedia techniques, standard engineering techniques and other techniques out of engineering. In this classification, the standard engineering techniques do not include the multimedia techniques. This classification indicates the limitation of attractiveness realized by standard engineering techniques.

The multimedia techniques realize sounds, graphics and so on as the game's attractiveness. However, we cannot find important issues for educational technology focusing on multimedia techniques themselves, because it is obvious that high multimedia techniques provide high quality of sounds and graphics. In addition, creating good multimedia materials and products is also out range of engineering technique so that we cannot well-handle this issue in educational technology. As for our handling area, we think that it is an important issue to determine how to control and integrate educational multimedia products in order to assist learning. The standard engineering techniques realize some attractiveness; time restriction, stage clearing, level up, puzzle, competition and so on, and therefore it is available to embed them in CAI systems. However, our investigation on embedding attractiveness is not enough because we cannot generally indicate how to embed attractiveness appropriately into arbitrary tasks and aims. This issue is very important for designing and implementing attractive educational systems Some of the attractiveness elements such as story, sounds and music are out from the engineering techniques. For example, a good story can be created by a professional writer and comfortable sound and music are composed by a professional composer. They are not generally engineers and they do not use engineering techniques for their creations. Therefore, we do not positively handle these elements of attractiveness on the engineering level.

5 Conclusion

In this paper, we have described the classification of video games and extracting attractiveness from video games as the basic investigation for developing attractive computer software. We also indicated the range for well-handling game's attractiveness based on engineering techniques. We believe this range is effective guideline for design and implementation of attractive educational system.

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Implications for Virtual Reality in Natural Resource Recreation Management Curricula

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Abstract: Since 1992, researchers at the University of North Carolina at Wilmington have been gathering data in multiple media formats concerning physical impacts due to recreation on Masonboro Island, a pristine barrier island off the coast of Wilmington, North Carolina, USA. The data have been integrated into a hypermedia database and are now being used by both managers of the island, as well as researchers. More recently, the hypermedia database was also used by students in a Coastal Natural Resources Recreation Management course in developing coastal management plans. One primary limitation which emerged from utilization of the hypermedia database in both academic and professional settings was the static media itself (eg. photographs, drawings). To address this limitation, navigable virtual reality images of Masonboro have been integrated into the hypermedia database utilizing Apple Computer's QuickTime VR system.

Introduction

Wilmington, located in coastal southeastern North Carolina, USA, is blessed with an abundance of natural resources. Perhaps the most notable of these is Masonboro Island, an 8 mile long, 5000 acre pristine barrier island ecosystem. Unlike the adjacent barrier islands, Masonboro remains undeveloped and primitive. For this reason, the island is managed by the National Estuarine Research Reserve as a critical site for not only protection of the resource, but also education, research, and traditional uses, such as fishing, oystering, and camping. The proximity of Masonboro Island to Wilmington, and the relative ease of access, allows high levels of recreation, and the resultant environmental impacts, to occur. Despite these pressures, the extremely dynamic nature of the barrier island ecosystem provides significant remedial forces within a geologically short timeframe.

The Hypermedia System

Since 1992, researchers at the University of North Carolina at Wilmington have been studying this relationship between environmental impacts due to recreation on Masonboro and the forces which mitigate this impact. Through funding from both the North Carolina National Estuarine Research Reserve and the North Carolina Sea Grant Program, an interactive, hypermedia-based computer system has been developed which encompasses the longitudinal data which was gathered on Masonboro Island. The focus of the system is to allow managers of the island to inventory, monitor, and assess impact data on-site. To this end, the system has been developed to be powerful, easy to use, and portable.

In addition to this managerial application, a collateral use of the system has emerged and has been implemented into the university curriculum. In the fall of 1994, the Masonboro Island hypermedia system was integrated into the REC366 Coastal Recreation Resources Management course at the University of North Carolina at Wilmington [Hill & Buerger 1996]. Within this course, the case study method of education as devised by Christopher Langdell [in Edginton & Griffin 1983] has been implemented allowing the students to use the hypermedia system to develop a management plan for Masonboro Island which accommodates traditional recreational uses, while at the same time protects the coastal resource base. To complement the use of the hypermedia system, the students, working in management teams, perform on-site analysis and interpretation, and work directly with professional resource managers, as well as additional mentoring resources, in order to fully realize the advantages of case study methodology [Willings 1968].

Through the use of the hypermedia system and this experiential implementation of case study method, the students literally assume the role of the administrator of the reserve in developing a management plan for the island. In essence, the hypermedia system allows the students the opportunity to effectively and easily access longitudinal impact data which was generated by university researchers and is currently utilized by reserve resource managers. Consistent with case study methodology, the system provides the students with powerful tools for accessing, organizing, manipulating, and analyzing this data in a manner which accommodates individualized styles of learning [Zeigler 1982].

This hypermedia system has proven to be an invaluable tool in the professional preparation process at the University of North Carolina at Wilmington. Understanding and interpreting real-world data, and applying it to management of natural resources is a vital educational experience for future resource managers. However, as with any system, there is room for improvement. A primary limitation of the existing hypermedia system is that it constrains the students' perspective in analyzing and interpreting the photographic hypermedia data in the system to that held by the original researcher. This constraint surfaces in two ways. First, when analyzing a photographic record of an impact site, the student only sees a static image of the site. He or she is unable to see, know, or understand the context within which the photographic record was taken. Second, the point of view from which this static photograph was taken was chosen by the researcher, and not the student. If given the opportunity, the student may have chosen an entirely different perspective from which to record the photographic representation of the impact site. This individualized perspective of the impact site could greatly enhance the learning potential of the system and alter the students' analysis and interpretation of the site itself.

Integration of Virtual Environments

To address these limitations, researchers at the University of North Carolina at Wilmington have integrated virtual reality (VR) environments of Masonboro Island into the hypermedia system. VR offers several potential advantages within the educational realm. First, consistent with case study methodology, VR allows learners to "more directly enter those digital worlds that, until now, we could only passively observe through the window of the computer screen" [Porter 1992, p. 42]. Second, this more direct interactivity should "amplify the powers of the mind to see previously hidden relationships in complex sets of data and to absorb, manipulate and interpret information more quickly and completely" [Virtual reality 1992]. These potential advantages of VR directly address the limitations of the existing hypermedia system, and provides educational flexibility by empowering the learner [Pantelidis 1993].

The virtual reality system selected for integration was Apple Computer's QuickTime VR. In QuickTime VR virtual environments, the user can freely navigate a "3 dimensional" world within one's computer. It is possible to develop these worlds to the extent where the user can gain a 360 degree perspective of the site, "grasp" objects within them, "pick them up," and "examine" them. It is important to understand that this is not "immersive" virtual reality wherein the user interacts with the virtual environment through such devices as headsets and datagloves. Instead, QuickTime VR allows the user to examine photographic panoramas or objects within a window on the screen using the mouse and/or keyboard to direct navigation and perspective. This allows for tremendous educational flexibility within the system while minimizing hardware requirements and costs.

The integration of QuickTime VR virtual environments has greatly extended the functionality of the Masonboro Island Hypermedia System and enhanced its potential as an educational tool. Therefore, it is our intent to incorporate the VR system into the undergraduate professional preparation curriculum in Natural Resource Recreation Management at the University of North Carolina at Wilmington. In using the VR system to develop management plans for Masonboro Island, the students will have the ability to adjust the perspectives of the photographic images through navigation of the scenes. This will allow them to understand the context within which the environmental impact occurs and to pick their own perspective from which to analyze and interpret the site. QuickTime VR virtual environments have the capability to expand the use of case study method and to improve student integration into the overall learning environment.

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In Search of Integrated Education: A Knowledge Management Approach to the Design and Development of Computer-Based Patient Education and Awareness.

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Abstract:
The provision of networked information resources and associated software applications has fostered important implications for the development of computer-based patient education and the way in which it can be placed and utilised in the healthcare setting. In the field of medical informatics, there is a recurring theme of integration and information sharing. At Velindre Hospital (a specialist cancer treatment centre) in Cardiff, South Wales we have developed *patient-knowledge management* software which embraces networked resource, networked computer-based education and the facilities for trading 'information and knowledge commodities', relating to patients, across information system boundaries. The *patient-knowledge management* software required to develop and support patient education in this setting is called DEICOMAH.

Introduction

In many cases, the competencies of information technology in the provision of computer-based education have out-paced the theories behind the paradigms needed to implement specialised educational applications. This is particularly true of computer-based patient education in clinical environments. Here, patient education is often inextricably associated with meaningful patient consent to treatment, shared decision making, patient compliance to treatment, and the triggers required for patient behavioural change [Skinner 1993, Gillispie 1993]. We believe that educational software for patients' informational and awareness requirements can not be developed in isolation from the information-rich environment in which they reside. As an example, computer-based patient education can now be utilised to contribute to external healthcare issues and objectives such as clinical effectiveness, needs assessment and patient-centred decision making. In the development process, consideration must be made as to the nature of these external requirements; development strategies must evolve to address the information flow between patient information systems and the boundaries of patient educational software. For these reasons, we have recontextualised the authoring process by encapsulating it in DEICOMAH - our patient-knowledge management software. We believe the supportive concept of knowledge management is necessary to develop educational applications *which recognise the potential of patients as health care resources who can provide unique insights into their own preferences for treatment and care* [Casper 1994]. This requires a well managed, computer-based, educational environment which can:- provide computer-based education and awareness strategies for patients, elicit patient-feedback and commentary about important health care issues (which we term a *patient knowledge response*), and store this within the patient information system in a format which health care providers can utilise. We refer to the concept of computer-based educational software which provides an information link between institutional mission objectives, issues and requirements, and localised educational support, as *educational integration*.

DEICOMAH and Patient-Knowledge Management

Expanding upon Knowledge Management Definitions

Knowledge Management in a medical context has been informally defined as the authoring, management, selective retrieval and annotation of knowledge for such purposes as education, problem solving and decision making [Greenes 1991]. However, this view of knowledge management does not fully embrace the characteristics and requirements of educational software for patients. With reference to the above, we have extended this existing concept and offer a description of patient-knowledge management which addresses the increasingly active and participatory role of patients in their own health care and their potential as a health care resource. In *Patient Knowledge Management*, we include: the authoring of computer-based patient education, the management, retrieval, utilisation, annotation and documentation of clinical educational resource, the mechanisms necessary to elicit feedback and commentary from the patients as they become more aware and knowledgeable about their disease, treatment options, side effects and outcomes (patient knowledge response), the storage of patient knowledge responses in the patient information system, and the use of the patient information system to provide patient data in educational applications..

An Overview of DEICOMAH

The DEICOMAH knowledge management software comprises a set of extended authoring and management tools necessary to attain the requirements of educationally integrated and well managed software in a computer-based educational environment [Hill 1997] . The 'electronic book' metaphor, which has been well documented in the field of educational computing and addressed in the field of education in medical informatics [Barker 1991, Richards 1991, Collis 1991, Santer 1994, Mooney 1995], is used to promote user-centred, collaborative development. DEICOMAH can be used to switch between three modes of development and management. Central to the knowledge management philosophy of computer-based patient education developed under DEICOMAH, is the provision of facilities to browse, identify, utilise and define external patient-related data which can be contributed to or incorporated into the educational software. Facilities are provided in a similar vein with additional administrative tools to utilise, develop and manage re-usable clinical educational resource. Administrative facilities also ensure data integrity amongst educational applications sharing both secure patient clinical data and educational resource. Once identified, the knowledge management facilities of DEICOMAH administer the necessary procedures to incorporate this into the application design. Other interfaces are available for defining new clinical or educational relational data structures if they are not identifiable in the patient information system. Educational resource browsal tools are also available for viewing and utilising multimedia such as images, text, audio and video files. Management facilities further include query tools, methods to match educational and clinical resource to individual electronic books, chapters and pages. They span: automated documentation and report generation, interactive views of the educational environment in which the educational software is used, data table definitions and data update/deletion facilities, a 'spy hole' facility to view run-time versions of individual pages in other applications, and access to the external patient information system data dictionary.

Work in Progress and Conclusions

At Velindre Hospital, we have been using DEICOMAH and the knowledge management paradigm to develop computer-based patient education, and have examined extending our philosophy to incorporate staff awareness applications into the educational environment. ADV (ADVisor) is computer-based educational software for male cancer patients addressing bladder, testicular and prostate cancers. It also addresses aspects of male sexuality often affected by the resultant treatment. The application is not used directly by patients, but supports the provision of tailored information for patients during cancer counselling and advice sessions with a specialist cancer nurse. Video, sound, pictures and text are presented to the patient and during the awareness process, information is elicited from the patient regarding preferences, concerns, expectations and decisions. This knowledge response is then stored as a supplement to the Hospital's patient information system. We are currently working on new interfaces of the patient information system to provide clinicians, responsible for the patient, with this unique patient response to health care issues, presented alongside standard medical records. We hope to extend the use of ADV to support informed consent to treatment and incorporate more formal methods of decision analysis if required. A full evaluation of knowledge management and its supportive concepts will shortly take place and early indications suggest that our knowledge management philosophy and supportive conceptual development paradigm have been of particular benefit in allowing nurses, clinicians and informaticians to conceptualise educationally integrated applications, and additional concepts such as databases, entities, attributes, entity relationships, modules, information systems, access control and security.

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A Multimedia System for Reinforcing Computer Programming Skills

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Abstract: Computer programming is a discipline that requires the acquisition and application of a wide range of knowledge. Students who find the techniques and skills difficult to learn are often not well served by remedial classes. This paper describes a system, *Periscope*, for reinforcing concepts in programming by providing an experimental environment in an instructional multimedia framework. Instructional material contains embedded examples that can be executed and can also be modified by the student in controlled ways. Periscope incorporates several forms of assessment that can be used both to identify students in need of help, and to measure improvements in learning resulting from the use of the system. It is platform-independent, and supports examples expressed in current imperative implementation languages.

1 Introduction

Learning to write computer programs is often difficult for students. For many, this may be the first time they have had to do something that is significantly more complicated than installing and using standard software packages. A majority of our first year computer science intake may be classified as novices, who are often overwhelmed by the technology, the language and the theory.

As a consequence, roughly 20–30% of the class will find it difficult (if not impossible) to keep up with the programming material—this roughly equates to a 10–15% overall failure rate, which is clearly undesirable. In addition, others may simply struggle through the course with a fragmented knowledge of the syllabus, which will handicap the student in their later years.

Over the next three years, first year failure rates are expected to increase as a direct result of lower tertiary entrance requirements. This is brought about by a desire to maintain student numbers at an economically viable level in the face of a decline in interest in some computing courses.

Computer programming is a complex task, requiring multiple skills and levels of understanding (see, for example, [Volet & Lund, 1994] and [Pea & Kurland, 1987]). Students naturally learn skills at differing rates, presenting increasing problems for instructors. The currently accepted practice of lectures supported by tutorials does not adequately cater for students who are struggling to keep up with the programming syllabus. Struggling students are less active, more withdrawn in tutorials and tend not to ask questions as the more advanced students dominate and set the learning pace. Suggestions that slower students be segregated from smarter ones is not a philosophically acceptable solution.

Recent attempts to conduct remedial tutorial classes on a voluntary-attendance basis was met with only moderate success. It would appear that students often do not want to be publically identified as those needing remedial work and often do not attend such classes. In addition, it was found that by the time we could identify the weaker students, these students often felt demoralised and were difficult to motivate.

2 Technological Support for Remediation

We need some form of remedial or reinforcement support that operates on a one-to-one basis. Committing additional teaching resources to remedial support is not always practical for anything greater than a small number of students without its becoming a time and monetary drain. Under these circumstances, we need to consider the use of multimedia computers as an adjunct to traditional teaching methods. Such a system would:

- be untiringly attentive, allowing the student to progress or repeat the teaching material at his/her pace;
- retain a student's right to anonymity in the class with respect to his/her performance;
- be used to monitor the students' level of competency and progression in order to provide instructors with data on which students require personalised help;
- allow a student to explore and experiment with code structures in a protected environment that serves to reinforce concepts introduced in lectures; and
- be flexible enough to present to a student materials that demonstrate the techniques that lead to a particular design or problem solution as well as the designs themselves. This is consistent with current metacognitive approaches to learning [Volet & Lund, 1994].

Such a system is under development. Through the use of multimedia incorporating color, animation, program simulations and interaction, the system is perceptually varied, easier and more interesting to use than similar print based materials. Being self-paced and less threatening than a classroom full of students, it is likely to be more effective. Although designed to help weaker students, advanced students may also use the system to reinforce and test their programming skills.

3 The Periscope System

A system for remedial or reflective learning of computer programming should be flexible, easy to use, and platform-independent. It should show the processes that lead to a particular design as well as the design itself, and it should incorporate several kinds of assessment. The software described in this paper is called *Periscope*, which (roughly) stands for Personal Environment for Reinforcing Skills in Computer Programming.

Figure 1 shows Periscope's components, which are based on standard multimedia technology. It uses a browser to present brief instructional material consisting of hyperlinked topics that introduce aspects of programming and software design, and are illustrated with many concise examples. The instructor develops the material with the help of the script editor; the student later views it using the browser.

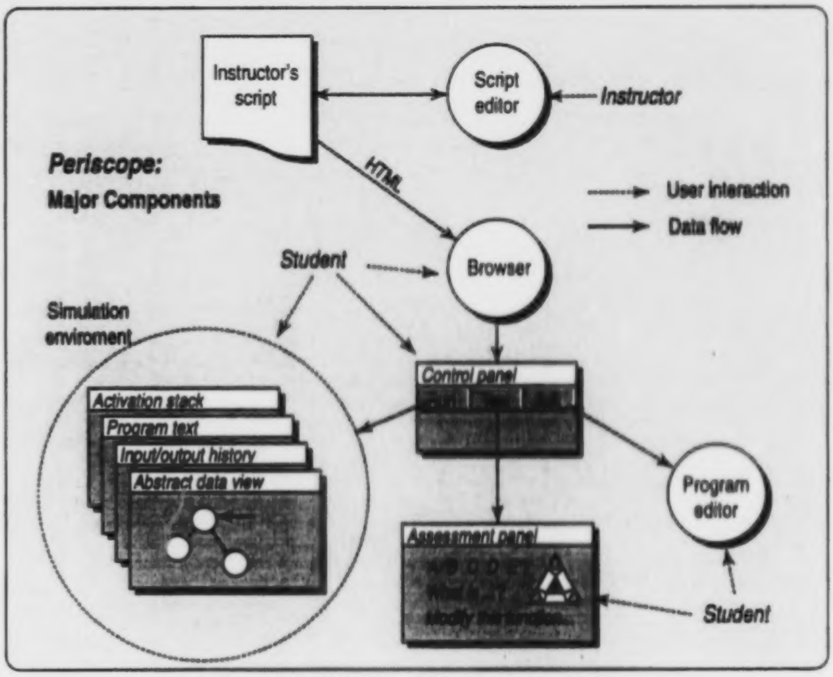
Instructor's script
Script editor
Instructor
HTML
Periscope:
Major Components
User interaction
Data flow
Student
Browser
Simulation enviroment
Control panel
Activation stack
Program text
Input/output history
Abstract data view
Program editor
Assessment panel
Student

Figure 1. Components of the *Periscope* System

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The key to the system from the student's view is the set of programming examples. These examples are not only illustrations of the processes and concepts being explained, they are also active regions, which when selected open up the control panel for a complete experimental environment. The control panel allows the student to invoke three main functions:

Run – creates a simulation environment where the currently selected program fragment is able to be executed. The simulation shows multiple views of the execution process, in order to enhance the student's understanding of program execution. As well as an activation record stack and the current textual execution point, such as is found in many debuggers, the simulation includes an abstract view of the data, modeled on the *Druids* data structure animation system [Whale, 1996]. Execution may be single-stepped or may proceed at a user-selectable rate.

Edit – opens an editor in which parts of the program fragment may be modified, thus giving the student an opportunity to observe changes in algorithm behavior. Only portions identified by the instructor as suitable for experimentation are editable; this reduces risk that the student may produce gibberish. After editing is complete the program is recompiled, and if syntactically and semantically acceptable it becomes the current program for animation.

Test – starts a sequence of assessment tasks associated with the example. Assessments range from simple multiple-choice questions to an analysis of the example as modified by the student according to the specifications given in the instructional material. The visual testing environment complements the experimental setup, as recommended by Szabo [Szabo et al, 1981]. An interesting feature is the use of Jody Paul's confidence-measuring response triangle [Paul, 1994], a mechanism that records a student's confidence in their answers on a three-choice scheme, and thus rewards partial knowledge.

An important component of the system is the script editor that permits the instructor to devise the whole course of instruction. As well as assisting with hyperlinks, it allows examples to be properly constructed and tested, with editable regions and parameters identified. It also supports setting appropriate assessment tasks. Assessments is an important aspect of learning, unless devising tests is made easy, benefits to the students will not be realized.

4 How the system is used

Periscope provides a rich set of functions that enables instructors to build elaborate hyperlinked and animated instructional scripts that can be viewed using a browser. These scripts determine the behavior of the browser when it is used by the student. For example, a script that is designed for remediation might contain more algorithmic animations and opportunities to experiment with example code fragments than one that is designed to reinforce learning.

Two of the key features in Periscope are its ability to animate difficult to understand algorithms and to provide a controlled environment in which students can dynamically explore and alter parts of the code using a program editor. The ability to alter the code exploits the benefits of exploratory learning as students are allowed to observe what effects their changes have on the code and serves to answer "what if" questions.

Periscope may also be scripted to identify conceptual gaps and difficulties that students may have with the syllabus. The range of tests include fairly simple self assessment tests through to elaborate assessments that require students to develop solutions based on their deeper understanding of the material rather than the regurgitation of facts.

It is essential that the instructor employs sound instructional design principles and is conscious of the medium's limitations when preparing the scripts. For example, reading large portions of text is a strain when viewed on a (small or slow refreshing) computer screen. Likewise, the placement, choice and quantity of examples used are equally important in helping to focus the student's understanding. The success and effectiveness of Periscope rests squarely on the quality and the design of the scripts.

5 Implementation

Periscope has only been partially implemented at the time of writing. The major components are implemented as Java applets to increase platform independence. The browser is either Netscape Navigator (version 3.0 or better) or

HotJava (the former applies more restrictions to locally-run applets than is warranted, but is more widely accepted for WWW browsing).

Data is passed between components of the system primarily as HTML scripts, with additional tag types used to specify parameters and attributes. In order to speed access to examples, some precompilation of the example code fragments in the script occurs at the time the instructor devises them. The control panel avoids compiling an example into Java classes for the simulator unless the student is working on a modified copy. Both the compiler and the simulator are browser plug-ins.

The current implementation of Periscope only supports (in the script) example code fragments that is either C or Java. C represents the most common choice for the imperative language in first and second year programming courses at present; Java is likely to become more widely adopted over the next few years. In principle, any procedural language that can be modeled in Java could be used for executable examples. All that is required is a browser plug-in compiler module for the chosen language (itself a major design feat, however).

Development is being carried out in a Unix environment presently. We recognise that it is important that Periscope be available for PCs and Macintosh platforms and the methodology used is intended to achieve this aim.

6 Evaluation

Whether Periscope will be a useful adjunct to computer science teaching will depend on empirical studies that are being planned. At minimum, its assessment scheme, used with a rigorously designed screening test, can identify students who are not thriving early in the semester. These students can be randomly assigned to three treatment groups: those using Periscope for remedial work, those attending additional face-to-face remedial classes, and those attending only normal classes for the remainder of the course.

What are the prospects for being able to establish improved learning among these students? A study [Whale, 1997] that involved only an animation system without integrated instruction showed that such tools may be more effective when used for revision than for new material. It is anticipated that the provision of instruction and a more flexible experimental setup can only increase its usefulness.

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A Distance Learning System for Computing and Information Systems Students

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Abstract: The design of a multimedia distance education learning system is more than creating a collection of multimedia courses. First we identified the learners and designed a learning model based on their needs and curriculum requirements. With systems development concepts such as rapid prototyping, object oriented design, and participatory we developed an integrated environment of courseware, instructional systems, and administrative systems to support the student from admission to completion of the programme. With our approach the roles of researcher, developer, learner, and teacher become more overlapped.

Design, Development, Delivery, and Evaluation

The goal of Athabasca University (AU) is to provide lifelong open learning (Race, 1994) by reducing barriers to education. Coordinators create courses at the University site while tutors are distributed across Alberta and students are distributed across Canada. Courses have been primarily print-based with telephone access to tutors. However, AU has been planning an online learning system since 1985 and has made progress towards that goal in several areas. Our goal in the Centre for Computing, Information Systems, and Mathematics (CCISM) is an electronic body of instructional support tools, curriculum content, and design strategies from which we can select materials for a particular course or module.

The first consideration in designing any learning system should be the learners. A system designed for mature self-motivated adults may be quite different from one for junior high school students. Students of CCISM are mature, self-motivated and open to using technology-based learning. The concepts of guided self-discovery learning (Holt, Fontaine, Gismondi, and Ramsden, 1995) and apprenticeship learning (Collins, Brown, and Newman, 1990) provided a framework for us in CCISM for developing an open learning system for a motivated adult learner. Within that framework, collaborative learning (Harasim, 1993) is particularly important for students in a CIS curriculum (Baecker, 1991). Finally, government, private industry, and students are pressing for an applied orientation in CIS that sometime conflict academic orientations. Situated learning - learning in real life situations (Brown, Collins, and Duguid, 1989) helps bridge academic motivations and the need for applied education and to support reflective and experiential learning (Norman and Spohrer, 1996). In summary the objectives of our learning system are to: 1. have the student learn at the time and place of their convenience,2. support self-guided discovery and apprenticeship models of learning, 3. support collaborative learning, 4. support situated learning, and 5. support both reflective and experiential thought.

We believe our objectives are best met by World Wide Web (WWW) based technology. We expect WWW standards for learning systems design will evolve in the same manner as standards for networking layers. To support guided self-discovery, we provide learning materials in hypermedia format (HTML) with links to WWW-based learning materials (Holt, Fontaine, Gismondi, and Ramsden, 1995) along with tutorial guidance. Collaborative and team building is supported by computer mediated communications (Holt and Gismondi, 1995) We extend the guided self-discovery concept to a apprentice model by project courses and work-experience. Students in projects courses and in work experience roles use tools for collaborative learning in helping design and implement the distance learning system environment (Holt and Gismondi, 1996. Computer based communications, projects, systems development work, and manning a "virtual help-desk" support situated learning The virtual helpdesk will be extended in the near future allow course specific help amongst students (Bishop, Greer, Cooke, 1996).

Experiential thought is easily integrated into computer based learning systems. Students are continually interacting with the computer and with one another through the computer. But reflective thought is more difficult concept to tie directly to the computer based learning system. Reflective thought in a CIS curriculum occurs in analysis and design and generating of algorithms. It may be nurtured by interaction with students and tutors and by access to appropriate computer based tools. A major role for AI in supporting reflective thought may be to support in a general way student exploration and collaboration (Clancey, 1993).

Participatory design in which users are directly involved in computer systems design has more recently been extended to the concept of learner centered design learning systems. (Norman et al, 1996). Learning occurs through the process of interaction with other learners and the environment. We extended Norman's (1996) concept of learner centered design by involving students in creating the courses and the learning environment itself. Students working on course conversions, design, and development have enhanced both the process and the product.

As in any development effort we are concerned with re-usability of code and integrity of data. Thus we try to use principles of oriented analysis and design such as data encapsulation and inheritance. Examples of how we follow the principles include things such as: data encapsulation - we keep the map coordinate files separate from the HTML and we will keep all the external link references in separate global link tables; and inheritance - we develop templates that can be modified for specific uses. In the longer run we hope the market will provide tools for building inheritance hierarchies for page objects and our authors will simply point and click and modify the objects. Currently shortcomings in current WEB technology constrain this approach; we have not found that development tools have matured to stage where we are comfortable abandoning "manual" HTML coding.

Rapid development of course materials is critical for the CIS curriculum. Student workers use the WWW available public domain visuals, HTML, and shareware utilities such as search engines and online testing systems to develop rapid prototypes. These materials are critiqued and revised by educational technology professionals. They iteratively replace the prototype material with more sophisticated material. Then we use those standards and course HTML templates developed in-house to quickly prototype new courses. Experience with the course design and delivery lead to modifications in the course that evolve the templates in a cyclical process

Other pragmatic approaches we have derived from systems design wisdom are naming conventions for files, and the creation of global directories for shared materials shared amongst courses (similar to the library concept). We also are looking at a source maintenance system (e.g UNIX based RCS for our students doing HTML from a distance) to handle file sharing by team members. We will be assessing special servers such as Hyper-G (Andrews, Kappe, Maurer, and Schmaranz., 1995).

Implementation of our learning system has been supported by an institutional wide instructional tracking system containing students identifiers, names, grades, course progress etc. It shares a database with the registration system maintaining data integrity across the institution. This reduces errors and frees up the need for redundant data entry time. Administrative systems support includes

Web-based registration and payment, and the integrated information system for registry, course materials, and finance. One of the most important areas that will require inter-institutional cooperation is a distributed library system.

"Situated research" is a very important concept for us. We believe the WEB is supporting a new research paradigm. Currently, much research in educational conducted in laboratories with statistically significant results and discussion those results being published two to three years after the fact. The WEB provides a means for other researchers to immediately experience students educational experience as the student does (visit http://ccism.pc.athabascau.ca). Further, the students become a direct part of the research and development cycle. Finally, we can pursue "situated research" in learning systems design and areas such as student modelling (Holt, Dubs, Jones, and Greer, 1994).

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Synchronized Audio/Visual Web Tutorial Modules

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Abstract: A relatively recent development in Web-based technology has provided the means to disseminate audio files simultaneously with graphics and text. This technology is better suited to the current limitations of bandwidth and speed of Internet connections than video, generates relatively small files, and can be augmented with vector-based animations as well as static images or text. The process for creating the audio files and the list of images to be synchronized is not difficult and requires software that is freely distributed. We are using this technology to create tutorial modules for problematic concepts in a majors' survey course in Biology.

In those university level courses where the instructor does not rely on a textbook, lectures are the primary source of information for the course. Students are required to be present in a specific location at a specific time, and, unless the lectures are videotaped, there are no further opportunities to hear and see the same presentation again. This limits accessibility to the course material and it does not allow students to review the information exactly as it was presented: they have only their notes to rely on, and these are not always completely accurate. The instructor may hold office hours where students can ask questions, but this is often too intimidating a setting for the student, or time conflicts prevent such access. One method of augmenting the live presentation of lectures is to videotape them and make the tapes available to students at a facility on campus. Videotaped lectures are often useful for many students, particularly those with language difficulties or processing disorders such as dyslexia, as they have control over the speed with which the tape progresses. The linear nature of videotape, however, prevents easy navigation between noncontiguous segments. In addition, the videotapes cannot be duplicated rapidly or cheaply enough for distribution to large lecture classes. Ideally, students should be able to review information germane to their courses, with fewer restrictions on access, but the material would be as immediate and as accurate as lectures. A relatively new Web-based technology may make such review possible.

This new technology, called Real Audio Synchronized Multimedia, allows a World Wide Web browser to play audio files that are synchronized with web pages. At specific times during the playing of the audio file, the page being viewed in the browser changes. This is not controlled by the user, but by a list of linked web pages created by the content author and interpreted by the audio player. Since the audio files begin playing a few seconds after they begin downloading, the user need not wait long periods of time for the entire file to download before listening to it. This also means that the audio file can be quite long – a one hour lecture typically begins playing 5-10 seconds after the request to the audio server has been made. This is true regardless of the speed of the user's connection: a 14.4 modem connection behaves about the same as an Ethernet connection, although the sound quality is somewhat reduced. There are a set of VCR-like set of controls visible that allow the user to pause, stop, jump forward or back in the file. The correct page is then displayed according to which part of the audio the user has selected.

The technology for producing and distributing streaming audio files synchronized to web pages has many advantages over streaming video or other web-based content delivery schemes. File sizes, and therefore storage requirements by the server, are approximately 3600 times smaller for these audio files than for video files: 3.8 Mb per hour for encoded audio files versus 3-5/Mb per *second* for video files. An entire year's worth of lectures could be stored on a 1 Gb removable cartridge for about US$90. The cost to the student is nonexistent as the client software is a freely distributed web browser plugin or standalone player. The software needed to record and encode such audio files is currently available free, while the server software is relatively inexpensive, especially when compared to video serving software. Once the audio files have been recorded, an encoder compresses them sufficiently that a one hour lecture file is only 3.8 Mb in size. The encoding process takes approximately one-fifth the length of the audio file, but does not require an operator's presence once encoding has begun. To synchronize Web pages with the audio file, any text editor may be used to create what is essentially a list of start and stop times for specific URLs. This text file is then encoded into a binary file that is placed on the same server as the encoded audio file.

The time required to assemble the audio and visual components of a synchronized set of documents depends on whether the content will be created *de novo* or taken from videotapes. If created from scratch, a written script greatly facilitates recording of the audio segment. On the other hand, digitizing the soundtrack of a videotape can be done in real time, although we have found that some editing is necessary to remove undesired segments or to add silent sections at the points where a new web page is loaded. Graphics creation or scanning is performed as it would be for any web page. Once the audio files are created and web pages are created that are linked to the desired graphics, the audio file can be encoded and the synchronization list can be created in a text editor or word processor. Start and stop times are listed for each web page in a return-delimited list and saved as a text file. This file is then encoded into a binary file and placed on the same server as the audio file. All other files may reside on any web server, anywhere. Files can also be set to be served locally from a hard disk or even a CD. Vector-based animation files can also be linked in the same way as graphics files using Macromedia's Shockwave Flash program for content creation and plugin for viewing. These files are small enough that downloading and playing them does not significantly degrade sound quality, although there are fewer operating systems (only Windows 95 and Macintosh System 7.5.x and Open Transport 1.1 or higher) that can take advantage of this feature than for static images.

We are beginning to evaluate this technology for delivering course content to students over the Web. Our educational goal is to provide a means for students to review and reinforce concepts presented in lectures, but without the restrictions of either live lectures or videotapes. By providing a means of studying that is independent of location and allows for non-linear jumps between segments of a presentation, the accessibility to the teacher's thoughts should be greater than that provided by lectures, office hours, or videotapes.

The initial stage of evaluating such methods will be the development of discrete modules centered around those concepts that are typically the most difficult for students, and hence require the greatest amount of time to assimilate. Should these methods prove to be effective, they could then be extended to include materials from all lectures. This form of content distribution could then, conceivably, be used in place of lecture, thus freeing the instructor and students to devote their time together to discussion of the material, rather than merely participating in a one-way transmission of information.

We hope to evaluate the effectiveness of this method by giving students a pretest and post-test on the material covered. Test scores will be analyzed for statistical significance.

Experimental Collaborative Information Networks

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Abstract: Collaborative Information Networks (CINs) are based on the principle that the collaborative monitoring, indexing and disseminating of information is more efficient than individual searching and monitoring. Following a brief introduction to CIN concepts and structure the following experimental networks are introduced: international news networks, networks for leaders, and an educational technology network.

Introduction:

The author has been conducting research related to Collaborative Information Networks (CINs, pronounced "Kins") since 1985 [Ibsen 1995]. The following excerpt from that paper summarizes the basic rationale for CINs:

> "It is proposed that the collaborative monitoring, indexing and disseminating of information is more efficient than the current practise of individual monitoring. Individuals in a collaborative network would monitor and index a limited number of information sources and share the results with others in the network. This would allow the collective monitoring of more sources of information than is possible by individual monitoring."

In the above mentioned paper, the author proposed developing CINs based on his proposal for an information structure (network and topics proposed by the author) and seeking people to collaborate in developing a network. In this paper the author is describing and proposing experimental networks based on information needs, existing communication networks and trigger goals [Ibsen & Lewis 1993]. Prior to a discussion of experimental networks a brief overview of the experimental network structure in given.

Experimental CIN Structure:

The basic structure of experimental networks is small groups of people sharing information using email with reference to sources of information such as Internet URL's (Uniform Resource Locators) and published materials. Groups are organized according to topics and the following levels of participation. Level one participants passively receive information which has been indexed by level three participants. Level two actively share information on specific topics with level three participants. Level three participants monitor at least one source of information and collaboratively share information with each other. They collectively select and index information to be shared with level one and two participants on topics of common interest. It is anticipated that no more than ten people work together at this level. Once that number is reached the group could subdivide by subtopic or other interest.

Funding for experimental networks (an email address and time) can easily be provided by network participants. In prototype networks funding could come from charging fees to level one participants. Another possible source of funding is to seek funding from commercial advertising.

To gather data and ideas for prototype networks the author is proposing to establish an experimental CIN related to CIN development with at least two sub groupings: one on people aspects of the network (the author could facilitate this) and the other on technical aspects of the network (the author is looking for a research partner(s) in this area). Other experimental networks are described below.

Experimental Networks:

As of March 10th, two sources of information are being used to facilitate the following networks: an international news network, networks for leaders, and an educational technology network. Two other networks (one on special education and the other for a non-credit class of adult learners) were explored but interest in participating in these networks was limited.

The international news network has several sub networks related to the author's interests and contacts which have similar interests. The sources of information for these networks are: Mercury Mail's <http://www.merc.com> free email news service funded by advertising and the UAISN (University of Alberta International Students Network) list server sponsored by the International Centre at the university. "International Update" another email list service of the university is also sent out to UAISN subscribers. The author selects information from these two sources and sends it to others participating in information networks which are of specific interest to them. These networks include the leaders networks mentioned below.

An email network for leaders has been developed from the need for one of the key organizations in the network to communicate with other organizations in the network re: special functions which are of potential interest to all organizations in the network. The initial thrust of the network was advertising a seminar sponsored by this organization. Information had been sent out by post inviting leaders to a breakfast meeting with an internationally known seminar speaker. The author was hired to phone these leaders to remind them of the breakfast and to gather email addresses and fax numbers for future communication purposes. It was found that a few organizations had email and most had fax. An experimental email network has been set up and an email/fax network was discussed. Another group of leaders is being approached with respect to setting up a network for them. Educational leaders are also being contacted with respect to networks for them.

A network on educational technology has been established with the anticipation that this will grow into a broader network on "Career and Technology Studies" (CTSnet). This network has the most potential of all the networks being explored because most of the infrastructure is in place to develop a fully functional prototype with a significant number of users. The main issue is funding and a related issue of time for users to participate in the network. It is anticipated that, if funding were found for central network development, end users would find the network so useful that they would prefer using it, to using current methods of obtaining information. To get funding for CTSnet and other networks the author is looking for trigger goals [Ibsen & Lewis 1993], which would facilitate CIN development and the goals of organizations using them.

At present the author is the only level three participant, with one or two others interested in participating at this level. Other level three participants can be added once some basic procedures are established between those interested. The author is currently developing these procedures using his experience in facilitating the networks mentioned above.

The author also hopes to explore international networks within the next year and present a paper at the "International Conference on Computers in Education" to be held in Malaysia, December 1997. See "y'all") there eh! OK La! (Southern USA, Canadian and Malaysian/Singapore slang).

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Quality in Distance Education[1]

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Problems in Distance Education

Distance education has been described both as different and identical to classroom teaching. There has been already a small body of research on distance education [Willis, 1992], where no significant difference was found between technology based and conventional face-to-face instruction.

Problems which have just been noticed in distance education seem to be shared by education in general. [Ehrmann 1995] points to the issue of students learning details but *not changing their own beliefs* as a result of distance education. [Jones et al. 1994] state that adult learners who think critically are better prepared to positively contribute to their communities and to society as a whole. Jones et al. propose a program for "inspiring educators to increase their knowledge of critical thinking in distance education". This emphasis on *critical thinking* is due to observed low performance. Much has been written on *transfer of learning* [Perkins et al., 1988], however, not in the context of distance learning per se. I have observed difficulties in the transfer of learning and applications to new situations. (See below). The problems of changing one's own belief, critical thinking and transfer of learning are issues from the kind of desired higher order learning that are problematic in all educational contexts [Riel, 1993, Hawkins, 1992].

A Distance Education Data Set

I have taught three quarters in a distance education graduate program. After examining my students' final papers, 36 projects, I found at least one of the aforementioned problems in many of the papers. The students' assignment for the final paper was to create a sequence of two lesson plans supported by a rationale from Gagne' and from constructivist theory. Additional theories were encouraged to be incorporated too.

Students final papers were evaluated for the application of Gagne's events of instruction and constructivist theories. The evaluation was YES (assignment fulfilled), PARTIAL(theory mentioned but not applied), or NO (theory not included).Results are shown in [Fig. 1] and [Fig. 2].

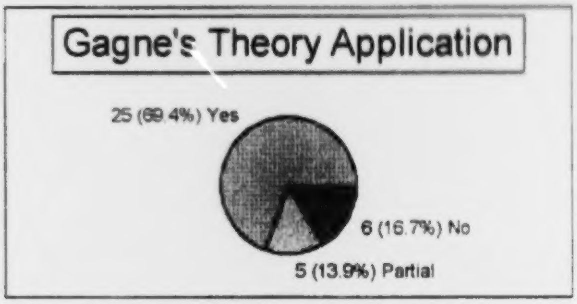

Figure 1: Success rate with the first assignment

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[1] A fuller version of this article, including references, is available on the CD-ROM.

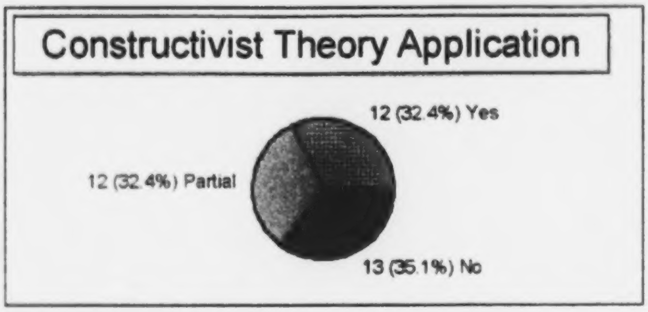

Figure 2: Success rate with the second assignment

When considering all three classes together only 69% of the students met the requirement of application of Gagne's theory, and only 32% of students met the requirement regarding the constructivist theory.

[Fig. 3] illustrates program development over time.

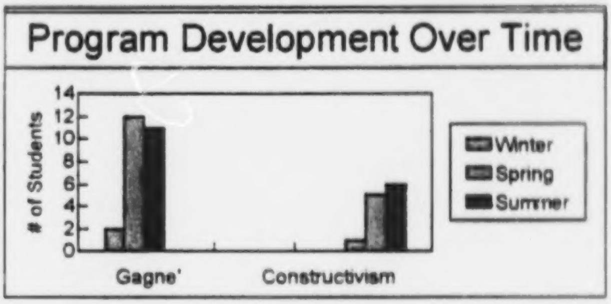

Figure 3: Increase in YES scores

In the first quarter (Winter) the number of YES evaluations is much smaller than YES evaluations in the Spring and Summer quarters. This improvement over time is true in both theories, but it is more true in the application of Gagne' theory.

Discussion

Distance learning programs need to mature. As [Fig. 3] suggest some problems will be solved over time. However, [Fig. 1] and [Fig. 2] show that a more profound change in teaching methods is required, maybe in the direction of cooperative learning, to bring upon desired quality in distance education. Cooperative learning holds the greatest promise to quality because the *multiple feedback* from group members, whole class, and instructor should lead to greater understanding and improved performance in distance education.

Problems with higher order learning have been recognized in many educational contexts. However, the solutions are somewhat different for every context. Distance education, for example, has its own set of conditions. [Turnbull 1987] already recognized five characteristics of distance education: accessible, flexible, user-friendly (with a high degree of interaction and adequate support systems), eclectic (employing a variety of media and teaching strategies) and egalitarian. Historically, these characteristics were implemented in most cases. If one listens carefully to these characteristics, one senses convenience and usefulness for the student, but not necessary curricular rigor and standards of higher order learning.

Distance Education Project in a Country with Transition Economy - Experiences and Lessons Learnt

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Abstract: The paper discuss the experiences gathered through introduction of distance learning at Faculty of economy at Ljubljana University. The part of the project considered with setting up of requested infrastructure is briefly presented. Future plan are explained.

1. Introduction

The tremendous changes in society over the past 25 years have broadened what is expected from higher education institutions. This has led to a change in their role and function as well as their educational structure. In addition to conventional teaching, more and more emphasis has been given to part time teaching, continuing education, retraining and different forms of vocational training, or in other words, to life long learning. The life long learning is associated very often with non-conventional teaching activities. These non-conventional teaching activities for students who work and study simultaneously mainly employ distance education methods, which can be ideally suited to these situations.

2. Country with Transition Economy

In the past decade distance teaching was established in many countries. Slovenia joint the major trend in establishing distance learning facilities relatively early, in 1994. Faculty of Economy from Ljubljana University (Ljubljana is the capital of Slovenia and the University of Ljubljana is the biggest and the oldest University in Slovenia) was the first higher level educational institution that launched the project for distance education. There are more reasons why the Faculty was the first institution to launch such a project. Later, the Faculty was appointed by the University as the co-ordination centre for all activities concerned with distance education.

The situation in country with transition economy (countries that turned their social and economic systems to open market economy after the fall of the Berlin wall) regarding the education in the field of economy changed dramatically with the changes in the social and economic life of the country. The former doctrine of socialist economy and self-management of enterprises which was common practice in all countries that appeared after the dissolution of Yugoslavia was abandoned relatively fast after the recognition of the new born states. New programs were introduced and new curricula developed. The changes in the program influenced the interest for study of economic sciences and management administration. The number of students at the Faculty of economy grow almost exponentially. From 300 new students per year, the number grow up to 1 500 (the limit of 1 500 was set up by the Ministry for education and sport) in the regular program funded from national budget sources. In parallel similar programs were launched for people that work and study simultaneously. The number of these students grow to 3 000 per year. This type of study required programs with flexible conditions, through which students are enabled to acquire degrees equivalent to those earned in regular state funded programs. This type of study where the majority of students live out from the site were the faculty is located become a challenge to the authorities and the educational staff. It becomes very clear that the technology which was introduced in the country through the academic and research networks should be used to meet the needs and the new challenge. Distance teaching appear to be the most efficient way to meet the requirements for the grow of the demands expressed in the regular and especially in the education programs for students that work and study. So, the project "Distance education at the faculty of economy" was launched and organisational structure was set up.

3. Distance Education at the Faculty of Economy, Ljubljana University

According to Keegan there are more models for distance education. Which one should be used depends on many factors i.e. the organisational structure of the educational institutions, the needs and the market in the country, the programs that are taught and the available infrastructure. In our case, the Faculty has to start from very beginning, meaning that the project needs as much as possible support from the educational institution that has experience in education and available organisational infrastructure. For that reason a project committee was set that consisted from members of educational staff, members from the financial service, the administration centre and from the publishing unit of the faculty. It was decided that this activity in its very beginning should stay as a part of the educational institution. The tasks were allocated to different members of the project team as follows. The organisational part of the education in the DLP (Distance Learning Project) was responsible for the promotion in the public media of the new type of study, consulting services in relation to the registration and matriculation of students, collection of registrations and fees. The other organisational part of DLP was concerned with the preparation of the lecture scheduling, preparation of the study material, organisation of the tutorial work, organisation of exams. Besides that, some activities that provided support to the project itself were also envisaged such as: handling data about students, tutors, electronic publishing desk and other information about DLP.

The next step was the evaluation of the students possibilities to access the Internet and the information infrastructure of the faculty. The responses were quite encouraging as 50% of the students reply that they have access to the Internet. For the rest educational centres were designed in every bigger city in the country. A person (employee) with task to care for the administration of such centre was envisaged. It was agreed that the administration in the educational centre will use the existing application for administration at the University of Ljubljana (FINISD). The application was designed for the Novell network systems and uses the IPX/SPX protocol. The publishing unit at the Faculty was invited to investigate the possibilities for publishing of the study material on digital media.

4. Setting up the Infrastructure

The existing information infrastructure was not in very good state. The national infrastructure of the academic and research network was just starting with its activities in the interior of the country from where the majority of the students that work were from. It was evident that the existing infrastructure where available should be used and were not available a new one should be developed. The project team realised that the existing infrastructure should be evaluated first and then the best solution for improving the existing infrastructure or setting up new parts should be selected. Two models for building up the infrastructure were used: the so called the model of the basic services and the optimal technical model. The model of the basic services was based on very cheap solutions which guaranteed only the basic services required by the DLP. The other model contained the solutions that provide best technical solutions in the context of the needs of the DLP. The choice which one to be implemented depended from the funds allocated for setting up the infrastructure and the first year needs of the DL educational process. The number of educational centres set up in the first year was relatively small i.e. only 3 such centres were established in the country due to the low number of students in the first year of such study. That was sort of an alleviator circumstance.

Both model were evaluated in the light of different criteria such as: reliability of the network, meeting the needs of DLP, the speed of data transfer and communication, the possibilities for further development of the network, security and data protection, cost and benefit. A comparison table was generated for both model and the solution that was chosen was the model of basic services. The topology of both models will be presented on Fig1, Fig.2 and Fig3. The technical optimal model was developed as a model with 2 options. In the first the basic infrastructure of the academic and research network is used in the second leased elastic lines from the national Telekom were used.

When the evaluation was finished , the building phase of the infrastructure followed. The type of connectivity was selected as well as the type of the servers and the type of the application software.

5. Instead of conclusion - Experiences and Lessons Learnt

It was quite evident from the first year of such type of education process that the students get accustomed very quickly to the use of the network and the basic services such as use of electronic mail for communication and the access to the WEB services. The transfer of educational material was not a problem too. The major problem appear to be the communication to tutors who do have attitude for use of the network regularly and are repulsive towards the new technology. Other problem appear to be the lack of facilities for video-conferencing (lack of equipment and bandwith) and other types of multi-media educational material. That requires further steps in the development of DLE.

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How Are Students Doing in an Online Course?
A Case Study of Factors Affecting Students' Online Discussions

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Abstract: This paper presents a case study of student and instructor interaction in an online course, Computers and Society. Through our initial analysis, we found that well-defined problems, questions, and issues elicited more and longer student responses than did those whose focus was less clearly stated. We conclude that in an online course, clarity helps alleviate student disorientation and focus student attention in the face of overwhelming numbers of online messages.

Introduction

Ideally, an online environment is interactive. It encourages active involvement and facilitates co-construction of meaning (Harasim, 1990). Participation stimulates cognitive restructuring through response to new information, agreeing and disagreeing, and challenging. One objective in a an online course is to engage students in these kinds of constructive conversations through building a student-centered environment.

This paper reports preliminary results of an analysis of student and teacher interaction in the online course, *Computers and Society,* taught by Frieda Mendelsohn. This course was delivered in the summer of 1996 through the State University of New York Learning Network, a project that offers several online college courses for alternative students. Seventeen students enrolled in the course which consisted of four types of learning activity: 1) responding to discussion questions; 2) critiquing an article; 3) presenting an issue; 4) presenting a final project. The first three tasks required student participation in online conversation. The fourth was a paper that students mailed to the instructor. Our analysis was based on the first three conversation-based activities.

Online Discussion

Our initial analysis of course data (records of all student and instructor messages) indicates that responses to the instructor's questions and to other students' critiques or the issues they raised were not evenly spread out. Why did some documents attract more and more developed responses that others? By undertaking a content analysis and comparing the kinds of discourse that attracted student input with those that attracted little or none, we found that clarity of questions and statements seemed to play a critical, determining role in whether and how much students contributed to a particular discussion.

For example, in Course Module I, the instructor posted four questions to initiate discussion. The first question began with the general statement of a problem (controversy surrounding the Information Superhighway), then narrowed the question down to a fine-tuned level of specificity. Finally, students were asked to list the kinds of cultures inhabiting the Internet and the resulting clashes between these groups. This question was well developed, concise, well-focused, to the point, elicited student opinion based on fact, and contained no distracting information. It elicited forty-four student responses. The second question, which attracted twenty-four responses, asked students to express their personal opinions of a course textbook question. The question concerned the author's concern that "teenagers have moved on to new delights". The instructor accompanied the question with two examples of teenage enchantment from the *New York Times Cyber Times* and asked students to react. Following were two notes with instructions for accessing this online publication and other pertinent sources. It seems that the core question became overshadowed by this abundance of subsidiary information and, consequently, its focus was lost to students. Though we cannot directly attribute this radical decrease in student responses (nearly 50%) to the density of the question itself, this highlighted the probable influence of question structure on student responses. The third question, moreover, which asked students to define cyberspace and state important questions concerning its influence in the future - a decidedly narrow and specific task, produced thirty responses.

In Module II, students posted their article critiques. Nine articles were selected and from these students produced sixty critiques. Some of the article critiques attracted multiple peer responses, while others stimulated none. Analysis of ten critiques selected for high response and low response indicated that a clearly presented viewpoint tended to elicit more and longer reaction than did cloudy ones. In one case where a student patently and vehemently disagreed with the author of an article on software environments and very carefully articulated his viewpoint, a lively, lengthy exchange ensued.

Clarity appeared to play an even larger role when students presented the issue of their own choosing in the third assignment. Again, there was a wide range in the number of responses based on how carefully the issue was expressed. The number of responses ranged from twenty-nine per issue to none at all. In comparing the most productive issue presentation with those that produced less response, it was clear that the manner of presentation and the number and quality of responses were parallel. The issue presentation that brought on the most student response (nine response layers) was well constructed and carefully laid out both sides of the issue selected: federal regulation of the Internet. By contrast, presentations that elicited a small number or no response lacked clear definition of the issue and failed to lay out both sides.

Conclusion

In an online course, a student is required to log on three times per week. In the intervals between log ons, multiple messages and threads of conversation have become part of the course environment. Numerous new documents from the instructor and other students are therefore on the screen each time a student logs on. Weeding through these documents and making sense of them is a time consuming task. It may be that by nature we are simply attracted to what makes the most sense with the least amount of effort; e.g., clearly stated questions, problems, and opinions.

Based on this case study, it is impossible to draw definitive conclusions regarding the relationship between clarity of presentation and the amount and quality of online discussion it provokes. Common sense would dictate that the clearer one is in articulating questions and opinions, the easier it is for one's interlocutor to respond. In the classroom we have the advantage of multiple, real time turn taking along with all the powerful intricacies of non-verbal face-to-face cues we make use of when negotiating meaning. These dimensions of communication play a critical role in supporting and clarifying our oftentimes messy oral discourse. Online, this is not the case. Clarity of expression, therefore, takes on much greater importance in electronic forms of teaching and learning discourse.

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Making the Transition From Traditional to Web-Based Course Material

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Abstract

Structuring traditional course material for presentation via the Internet appears to be causing confusion as to who does the structuring and what should appear on the Internet. Instructors are often given the responsibility for structuring their material and determining the types of activities that should be supported without a working understanding of what a web-based course presentation would look like or work like. What is described in this paper is a methodology and a conceptual tool for helping instructors bring their course 'on-line'

Introduction

The conversion of traditional lecture based course material to Web based material is bringing to light a number obstacles. Specifically, it appears difficult to structure existing material to take advantage, even minimally, of an Internet-based presentation of the material. It is hypothesized that the reason for this originates in the imposition of a steep learning curve. That is, instructors must learn 1) how the web works, 2) what activities to support, and 3) how to structure hyperlinked presentations. This paper will describe the problem and the proposed solution.

The Context

The Distributed Education Unit (DEU) at the University of Calgary provides web-based course support for the Department of Community Rehabilitation. The mandate of the DEU is to provide technical support in terms of hardware and software and to provide leadership in the area of Internet based provision of course material e.g. distributed education. The expectation was that instructors, being the content experts, would structure the course material prior to submission to the DEU leaving the task of converting the material to web-based material to the staff of the DEU. What was found, however, was that many instructors were providing their regular course material without structuring it in any way. This placed the DEU staff in the position of attempting to structure material without benefit of content knowledge and to determine what sorts of activities would support the material. In other words the staff of the Deu were expected to fulfill roles of content experts and instructional design. While the latter may have been within the purview of the DEU, the former clearly was not.

Problem Definition

Traditional course material consists of course notes, lecturing, overheads, perhaps movies, and, of course, tests. A high level of interaction within the material (hyperlinking) is possible. That being said, however, not all material nor high levels of hyperlinking, should be used in web-based presentations.

Traditional classroom and instructor-student interaction involve communication modes including, most often Face-to-face (FTF) or voice, and increasingly, email. Activities that involve group work are also part of many traditional classrooms. Student activities also include peer interaction.

There is often a desire to support as many of the traditional activities as possible without a clear understanding of what that support would look like. Instructors are faced with the dilemma of selecting material for a medium of which they have little knowledge.

Problem Solution?

In order for instructors to structure their course content for Internet presentation they must know something of the way in which web based pages, and the Internet, go together. That is, they must have a working understanding of how their material will look and how students will interact with it, and most importantly, the limitations of web based pages.

A means of flattening the learning curve has been devised that should serve to assist instructors to structure their content for an Internet based presentation. The learning tool being developed consists of an informational booklet that outlines the various services offered and a detailed example of the process involved in preparing a course for a web-based delivery. A task analysis, on a course by course basis, of what both students and instructors do while engaged in a course helps to structure or provide conceptual tags with which to build upon. The next step is to begin building a room metaphor around the task analysis i.e. where do these activities take place. Once the room metaphor has been sketched out it becomes possible to show how some hyperlinking may occur (see Figure 1). It is possible at this point to illustrate the demands of each type of room. For example, lecture rooms may be primarily text-based with some limited visuals. Interactive rooms, such as a student lounge area, may demand some way for students to interact. This metaphor helps to define what is needed from the Internet-based material and provides an opportunity to explore what is possible using Internet-based material.

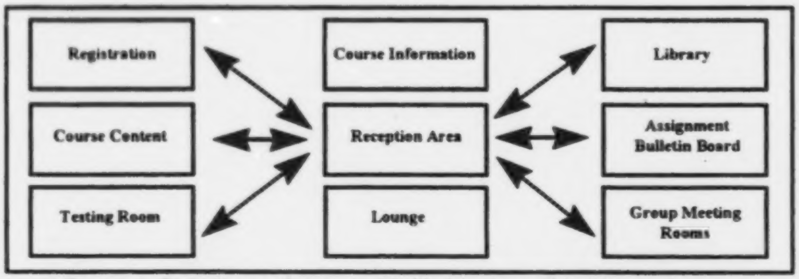

Figure 1: Sample set of rooms with likely subset of linking pathways.

Once the rooms have been clearly defined and discussed it becomes possible to have a look inside each room. What, for example, would one find in the library? Thus an opportunity is awarded to 'sort out' or structure course material with an eye towards which room the material belongs and how it may be linked together. Furthermore the constraints of an Internet based presentation, as well as the possibilities, help structure the material in interesting new ways.

Conclusion

This project has only just begun and so represents a work-in-progress. Over the next year this instructional technique will be used both on an individual basis and with groups. Efficacy will be judged by comparison of current problems with those of a year from now as well as ongoing feedback from instructors and students.

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Development of Interactive, Multimedia Educational Software for Studying Native American Cultural History and Foreign Languages.

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Abstract: Faculty at the University of Arkansas are developing interactive multimedia educational software modules for students at junior high, high school and college levels. The purpose of this software is to give students an opportunity to learn a foreign language and to learn about Native American and European encounters in the Lower Mississippi Valley in the 17th and 18th centuries. With this software, students will have the option to move through three different learning levels to gather the information and skills needed to better understand foreign languages and to better explore ethnohistoric events of the past. The program will follow an "interactive spiral effect" as introduced in [Kozell 1996]. Such an effect will invite students to explore various activities and materials in one level, and will invite or "entice" them to learn more in the next. The program is currently under development and will be finished by the year 2000.

Picture this! You are working at your computer and suddenly you see an authentic 17th century French document of the encounter between the Quapaw Indians of Arkansas and French missionaries from Québec. But, there's more; you click a button and view a simulated movie of this event along with narration, maps, pictures, Arkansas River mud, live alligators snapping at your heels and...well, I am getting a little carried away, but nevertheless, exciting things are happening at the University of Arkansas-Fayetteville! In September 1996, the Department of Foreign Languages at the University of Arkansas and the Arkansas Archeological Survey were awarded a grant in the amount of $180,000.00 from the National Endowment for the Humanities to develop interactive, multimedia educational software (CD-Rom and World Wide Web platforms) for students at the junior high, high school and college levels. Since the grant was awarded, faculty from both departments have begun work on the project which, when completed, will offer students opportunities to learn French and/or Spanish while studying the history of Native American encounters with Europeans, African-Americans, and Euroamericans. The main focus of the project is on Native American encounters in the Mississippi Valley. This region, including Arkansas, was chosen because it witnessed a greater range of cultural encounters, involving English, French, and Spanish colonists and dozens of distinctive Native American groups, than is the case in many other New World settings.

For this project, we are using cross-platform authoring software packages, (Macromedia Authorware and Director), which bring a maximum amount of flexibility and creativity to the forefront. With this software, we are able to design an active learning structure which will enable students to acquire knowledge and to develop critical-thinking and problem-solving skills relevant to the humanities in general and, more specifically, to the disciplines of foreign languages, anthropology, geography, history, and social sciences. As we work on this project, our goal is to organize it in such a way which will allow software users to navigate through modules representing increasingly challenging levels that range from introductory presentations of basic concepts and learning skills to opportunities to analyze data sets and to complete problem solving tasks relative to cross-cultural communication and interaction. The project itself will have self-directed interaction with texts (including authentic foreign language historical documents), maps, graphics, animation, sound, and interactive exercises to interpret the events in the Mississippi Valley during the early stages of colonization. Since we are developing both CD-Rom and World Wide Web modules, instructors will have multiple means to use computer technology to teach students how to use information from archeological and historical sources to learn a foreign language and/or to learn about Native American cultural history. Once the program is completed, we will not merely provide students with a multimedia encyclopedia, but will help them to develop the skills that are necessary for creative inquiry and problem-solving in the humanities.

We anticipate designing 5 modules for this three year project. The template for these modules will contain three different educational levels. For example, in Level 1, basic concepts relative to a given module's content are introduced with activities suitable for illustrating those concepts and developing basic learning skills. In Level 2, more detailed information is provided along with opportunities to apply critical thinking and problem solving skills. Here the emphasis is on knowledge building, information evaluation and problem solving activities. In Level 3, advanced information and tools are provided to help users to create and analyze data sets. Using this template, students will have several modules from which they may choose, each surrounding an actual historical event or circumstance.

Students will also have the option of studying the material in French, Spanish or English. For example: Students select the "Interactions" module in the French language. In this module, the students explore historical documents and compare and contrast Native American and European views of contact and interaction to enhance their understanding of the issues of intent, expectation and outcome in situations of cross-cultural communication. Two encounters are discussed here: The first, the 1699 calumet ceremony performed for Father Davion by the Quapaw which was a friendly offering shared by both cultures; the second, a 1729 encounter between the Jesuit Missionary Paul du Poisson, and the Quapaw, which provides a contrast in that du Poisson rejected the offering of the calumet, a symbol of alliance, because he did not want to reciprocate the Indians' offer with a repayment of gifts.

In Level 1, students work through basic language exercises which allow them to hear and to see short French phrases, accompanying pictures, and a map of the region indicating the locations where the encounters took place. Simplified texts and illustrations of selected Native American and European greeting ceremonies are provided with exercises that prompt users to identify the settings for these ceremonies, their participants, the objects used and major elements of the ceremonies. After working through the exercises, various comprehension questions follow to verify basic understanding. The global question is Why? Why was one encounter successful and the other not. Students are invited to hypothesize and to explore further information in Level 2.

In Level 2, students review additional information, in French, on Native American and European rituals and their cultural meanings. Screens and dialogue boxes provide exercises in which specific elements of ritual performances can be matched with their associated cultural meanings. Users can compare and contrast the meanings of several ritual performances to identify similarities and differences in the views of several Native American and European groups. At this level, students are able to access many Level 1 features such as vocabulary and comprehension checks. Users hear and see again the information from Level 1 but are now provided with new exercises which permit them to identify Native American and European objectives and common problems affecting participation.

In Level 3, students obtain richer historical and cultural information about these encounters and view the authentic historical documents containing information on subsequent encounters and interactions among the participants in the greeting rituals previously examined. Here users can employ interactive tools to develop second language reading skills, and/or to create new data sets of examples of Native American and European expectations and outcomes following the previously-concluded greeting rituals. Resolution at this stage is achieved by using tools provided to organize, format and print or download the selected texts and/or data sets.

Aside from the modules developed for this project, there will also be links to various on-line sources for in-depth, university level study of the cultural and historical settings and events in the Mississippi Valley. Once the project is completed, the two versions of the program (CD-Rom or World Wide Web) will be available to schools free of charge.

The learning process can perhaps be most effective by teaching across the curriculum, where information is provided and basic learning and thinking skills are acquired across a variety of related subject fields, rather than on a subject by subject basis. As a result, students will become better able to grasp connections among separate bodies of knowledge and will better understand the relevance of alternative perspectives and multiple points of view. Because of the integration of foreign languages and anthropology in our project, we strongly feel that this combination will provide a holistic environment in which foreign languages and historical and cultural materials can be combined to enhance the learning process in each subject area. And too, this approach (using the World Wide Web/CD Rom) will bring rare, exciting and yet important information to students, teachers, interested viewers and colleagues who otherwise may never have an opportunity to explore authentic texts, graphics or events of the Lower Mississippi Valley.

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The Animal Diversity Web

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Abstract: Since January 1995, faculty curators at the University of Michigan Museum of Zoology have taught an innovative undergraduate course: Biology 108, Introduction to Animal Diversity, intended for students who are not Biology majors. To support this course, we have created the Animal Diversity Web (ADW), a tool for (1) teaching post-secondary students about the ecology, biosystematics, and conservation biology of animals; (2) using inquiry-based learning to teach students general patterns and principles in these fields; and (3) improving students' knowledge of what science is & how it works.

1 Instructional Problem

There are two special problems created by the format and content of *An Introduction to Animal Diversity*. First, non-major students do not want or need highly technical descriptions of the animals they study. They are more interested in – and as voters, will have an impact on – conservation, natural history, and areas of ecology and evolutionary biology that provide the scientific foundation for environmental biology. We have been unable to find a textbook that takes this approach. Second, because this course is taught by a ten or more lecturers (each a specialist in a different aspect of biological diversity), continuity is a problem. Lecturers differ in style and emphasis. We needed a means of providing a consistent nucleus of information about each group of animals. This problem was especially acute because we lacked an appropriate textbook.

2 Solution: The Animal Diversity Web

A collaboration between the Museum and the ITD Office of Instructional Technology explored emerging technologies to help solve this problem. Those discussion quickly focused on the possibility of using the World Wide Web. The result, much modified, honed by two years of experience with classroom use, and ever-growing, is the Animal Diversity Web (ADW).

2.1 Scope

The nature of the World-Wide Web is very well suited to the hierarchical nature of animal classification. The ADW itself consists of three components: a large collection of images, species accounts describing individual species, and characterizations of higher level groups such as phyla and classes.

For each group, we provide information in the form of both text and images. Descriptions are provided at higher levels of classification (Phylum, Class, Order, Family) and at the species level. At the bottom level of the ADW are species accounts (such as the gray wolf or the moon jelly), providing details of distribution, natural history, economic importance, and conservation, and when available, a photograph. They are prepared for individual species using a standard format; currently, we have around 800 such accounts.

Because our experience with animals is primarily visual, a collection of high-quality pictures is critically important to the ADW. Currently, it includes approximately 1000 images. Many of these were taken from our own collections of color slides. Other images are taken from commercially-available CD-ROMs, Internet sources (the Smithsonian, for example, provides a large number of images for non-commercial use), and in some cases from sources such as textbooks where we have purchased the right to use the pictures (the latter category is only available to users in the .umich.edu domain).

The images depict animals representing nine Phyla. These Phyla were chosen because they contain >99% of all animal species and because they are most of the Phyla discussed by our lecturers. We have written text describing each of these Phyla, and in addition, at least 40 Subphyla and Classes. The section on mammals is most complete. Here, we have around 250 images representing approximately 230 species. These show examples of all 21 Orders of Mammals and nearly 100 Families. Text has been prepared to describe all Orders and about 50 Families.

2.2 Structure

The ADW, like animal classification itself, is hierarchical in structure. Students navigate through it to find information using four methods: the taxonomic hierarchy, shortcuts to major groups discussed in class, a search form, or a visual representation of the structure.

The search form is based on the same structure as the individual species accounts. Users can search for a specific account not only by the animal's common or scientific name, but by combining other characteristics as well. For example, after reading about the gray wolf, a student might wonder, "Are there meat-eating mammals who are not in the Carnivore Family? How many?" Another might wonder, "What other animals exhibit pack behavior?" Both of these questions could be explored within our structured search tool, by specifying appropriate criteria for the various categories of interest (food habits, family, behavior, etc.).

2.3 Student Participation

Students actively participate in the creation of the ADW by writing species accounts. Students in Biology 108 choose two animals (one vertebrate, one invertebrate) to research. Their research is scaffolded by the Species Account Template. The template (created in SuperCard) provides a series of fields and checkboxes to ensure that student-written accounts cover the appropriate topics in a standard format. Students also use this template to electronically submit their species accounts.

Students respond enthusiastically to this assignment, as it allows them to apply the terms, concepts, and big ideas they learn in lecture to a specific animal of their choosing. Because accounts are published on the Web, they have an authentic audience for their work. In addition, students in the class participate in peer review of one another's accounts. This process has dramatically improved the quality of the species accounts, by reinforcing the presence of an authentic audience. Final review (for accuracy) is done by the professor for the course and teaching assistants before accounts are incorporated into the ADW. (Additional technical details on site infrastructure can be found in the CD-ROM version of this paper.)

2.4 Inquiry Assignments

While some students are fascinated by the ADW and explore it thoroughly, other students need to be encouraged to take advantage of the resource. The search feature of the ADW helps meet this goal. This capability can be the basis for an enormous variety of questions, limited only by the information in the species accounts. Example assignments include the following:

- Consider bats who eat fruit and those who eat insects: How are they similar in terms of size, gestation length, and geographic distribution? Different?
- Do endangered species tend to be concentrated in certain parts of the world? To be especially large or small in body size? To belong to a particular trophic level?

These questions are very well suited to small discussion sections. They require information gleaned from a large number of species accounts, so a group of students can collaborate to answer them. The questions get at some of the most fundamental concepts taught in the course. They force students to synthesize, not simply regurgitate.

3 Importance of the Animal Diversity Web

As it exists today, the ADW is a cornerstone of instruction about biodiversity. Currently, it serves Biology 108 and other classes at UM, and has daily visitors from around the world. The benefit of the resource is directly linked to the scope of the collection. The ADW provides students with ready access to images of animals and to text that emphasizes natural history and conservation. Combined with the searching function, the ADW has also proved to be an exceptional tool for teaching general concepts in ecology and evolutionary biology. In part this is true because it allows us to illustrate these concepts with a rich library of examples. More importantly, with properly framed questions, we can lead students to explore natural history in a way that permits them to discover basic principles for themselves. The ADW facilitates the presentation of information, but it also allows us to give assignments that force students to search for patterns and synthesize information that crosses the usual lines of animal classification.

4 Acknowledgments

The Animal Diversity Web has been created in a collaboration between the University of Michigan Museum of Zoology and the Office of Instructional Technology (part of the Information Technology Division), with funding from the College of Literature, Sciences, and the Arts.

Design of a Virtual University in a Korean Context

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Abstract: The purpose of the virtual university in general is to expand access to higher education for individuals scattered all over the world, to remove barriers of time and space, and to develop a cost-effective approach that provides an interactive learning opportunity for adults. The Korea National Open University launched a two-year project to design a virtual university in the Korean context as suggested by the Presidential Commission on Education Reform in February, 1996. Purpose, structure, programs and delivery modes of the virtual university are outlined along with the nature of the university.

Introduction

With the development of new information technologies, the idea of a virtual university has been realized to bring wider opportunities to people in the form of flexible, open and distance learning system. Among these information technologies, satellite TV, video-conferencing, and high-speed computer networks - including the Internet - have been adopted as major interactive media to deliver courses at these virtual universities. The purpose of the virtual university in general is to expand access to higher education for individuals scattered all over the world, to remove barriers of time and space, and to develop a cost-effective approach that provides an interactive learning opportunity for adults.

Teaching at a distance in Korea began with the founding of the Korea National Open University(KNOU) in 1972. In 1996, KNOU launched a two-year project to design a virtual university in the Korean context as suggested by the Presidential Commission on Education Reform in February, 1996. The Presidential Commission on Education Reform, has defined the goal of the Korean Education System in the 21st century as an "Edutopia", a utopia of education. As one means of realizing an Edutopia in Korea, the foundation of a virtual university was suggested. KNOU has taken the responsibility to participate in designing this virtual university.

Concept of a Virtual University

Virtual universities in the world can be categorized according to their uses of different media. Some universities such as National Technological University in the USA use satellite TV for delivering courses and the Internet for interaction. Other universities such as Virtual Online University use the Internet and other multimedia as their main delivery and interactive devices. There are some institutes which use the Internet only. All these universities deliver their courses beyond the walls of the traditional university classroom and move the campus to the cyberspace horizons.

Virtual university can be described as a higher education system that adopt computer and telecommunications technology to organize, develop, manage, and administer learning. Limitations of space and time restrictions can be disappeared in a virtual learning environment. If synchronous instructional activities are needed, various types of teleconferencing technology can be used. A virtual network of students, instructors, administrators and information is established on the basis of the development of information technologies.

Design of a Virtual University

Purpose

A virtual university in a Korean context is seen as an alternative form of existing higher educational institutes, which will broaden the range of higher education opportunities for the people of Korea. And indeed, one's credits earned through the virtual university will be saved in the National Credit Bank to be awarded appropriate degrees or certificates. The virtual university will also contribute to reduce the costs of providing higher education opportunities to adult learners by adopting information technology and sharing educational resources.

Programs

The services of the virtual university have to be market-oriented, learner-centered, degree-granting, high quality, and cost-effective. The lifelong learning needs of adults will be assessed to provide flexible innovative courses. Credit courses, non-credit courses, certificates of specialization and degree programs at undergraduate and graduate degree levels can be offered at the virtual university.

Structure and Function

A central cyber-office of the virtual university will offer administrative and managerial services including the development of courses, the maintenance of academic records within the system of the National Credit Bank as well as financial management of the institution. The virtual university will cooperate with existing colleges, universities, training centers and other post-secondary education institutes in developing its courses. The faculty members and instructional designers of the virtual university will have a primary responsibility for developing virtual courses. There will be several schools in the virtual university, each with major programs.

Regional study centers will be housed in 41 study centers of the Korea National Open University, public libraries, local colleges and universities to provide distance learning courses and support services to the students of the virtual university. By on-line or personal tutors, systematic support for individual students will be provided as forms of monitoring, evaluating and reporting academic progress throughout each course.

Course Development and Delivery Mode

Course or program providers for the university will be solicited throughout the nation. The programs of the virtual university will be provided primarily by institutions of higher education and private training sectors in Korea and other countries. Nationally recognized experts in their fields of study can be engaged as creators of courses and curricula.

The primary delivery modes of instruction will be computer-mediated communication system including the Internet and CD-ROM. Video-conferencing system will provide opportunities for real time interaction.

An Intelligent Hypermedia Teaching System for Chinese Language Learning in Primary School

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Abstract: This paper describes an intelligent hypermedia teaching system for Chinese language learning in primary school and shows the design and implementation of four important models in this system,including main learning environment , hypermedia knowledge-base, student model and intelligent navigator. The purpose of developing this intelligent hypermedia teaching system is to survey the impact on Chinese language learning resulted from appearing of intelligent hypermedia and to attain some experience for developing such intelligent hypermedia teaching system.

Introduction

An intelligent hypermedia is a new information technology which combines both AI technology and hypermedia technology together. An intelligent hypermedia teaching system integrates the advances of both the ICAI and the hypermedia system and eliminates their defects.

Now we are developing an intelligent hypermedia teaching system for Chinese language learning in primary school. Our purpose is to survey the impact on Chinese language learning resulted from appearing of intelligent hypermedia and to attain some experience for developing such intelligent hypermedia teaching system.

Overall Design of the System

According to learning regularities of Chinese language. this system provides the students two learning environments: One is the main learning environment which shows the students hypermedia language material. another is the subsidiary learning environment which is actually hypermedia knowledge-base.The students can enter any learning environment. The main learning environment is the main interface between the students and the system. The students can do exercise in the main learning environment. And if they encounter some difficulty ,they can jump to hypermedia knowledge-base to learn furtherly. Those errors made by the students are saved in the student model and will be diagnosed in order to generate remedial strategies. The selection of learning material , instructional objectives and type of exercise is not decided only by the computer tutor. The students can participate those dicisions in order to make proper selections.

The system contains four important models which are described as following: the main learning environment, hypermedia knowledge-base,intelligent navigator and error diagnosis model.

Design of the Main Learning Environment

The main learning environment is used to show language material. Those language material are organized in form of hypermedia in order to provide the students active interface. There are two kinds of object in the learning environment: objects for learning and objects for activating. In the main learning environment the student can do some exercises. The system selects proper questions ,which can be either generated automaticly by the system or provided by an external questions base,according to the student model.

Design of Hypermedia Knowledge-base

In the hypermedia knowledge-base ,the knowledge is represented by structural nodes and links. Here the structural node is defined as two parts:type of node and knowledge-slot list. The type of node is defined as (name of type,value of type). Knowledge_slot is defined as (attribute name ,attribute value). Different from traditional hypermedia system, the links in hypermedia knowledge-base is also structural. A link structure contains starting node,ending node, name of link,types of link,attributes and link functions.

Student Model and Error Diagnosis

Out structure of student model contains sevel parts as following :The index to instructional objective unit to attain: The degree of attaining current instrcutional objectives: A wrong knowledge unit list; The type of question met already and number of exercises which have been done; History record of navigation in hypermedia knowledge-base; Record of language material learnt by the student; Some nonintellect factors,such as age,sex,some flags(such as background music,playing speed of video,sound volumn etc.) needed by the student in the learning environment .

Error diagnosis is the most important and the most difficult model of the system. We are building more efficient grammar and semantic knowledge-bases of Chinese language to detect error made by sudents.

Design of the Intelligent Navigator for the Hypermedia Knowledge-base

The intelligent navigator for the hypermedia knowledge-base has some special functions: informatin filter,position marking and effective guide and answering questions.

Interactive 3-D Physical-Simulation Environment in a Virtual World

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Abstract: This paper describes a method for achieving an interactive 3-D physical simulation environment in a virtual world using the Java language. The simulation environment is constructed of generic and basic Java class objects, such as environmental properties, object properties, simulation engines, and interactions between objects, which can be reused and make the simulation environment more extensible. In this application, students can conduct basic experiments, such as observing balls falling and bouncing on a floor and their motions after colliding with each other.

1. Introduction

Self-discovery learning using interactive learning materials has become an important topic in the field of computer-aided instruction (CAI). Example of such CAI systems are the Interactive Learning Environment (ILE) and Micro World [Okamoto, 1994]. Several Micro World systems have been developed for both 2-D and 3-D interactive physical simulation, for example, Interactive Physics [Interactive Physics 1997]. In these simulation environments, learners can change property parameters interactively, but the environments are not extensible because they are implemented using a compiler language, such as C or C++. Therefore the experiments that can be conducted are limited by the system integration. In this paper, we propose a method for achieving an interactive 3-D physical simulation environment in a virtual world which is extensible using the Java language.[JDK 1996].

2. Use of 3-D physical simulation environment in a virtual world

An interactive simulation environment in a virtual world functions as a virtual science laboratory, much like a real one in an elementary or junior high school. This type of environment enables users to perform various virtual experiments. They can change the parameters interactively, including both the environmental properties such as gravity and objects' properties, such as their initial velocity, initial position, acceleration, and resiliency. Users can predict the results of changing the property parameters, then run the experiment and watch the results on the screen immediately. Users can also "walk through" the 3-D virtual world in which the simulation experiments are performed, enabling them to observe the phenomena from various viewpoints.

3. Implementation

3.1. Software used Java

Java is an object-oriented, interpreted, secure, architecturally neutral, portable, and dynamic programming language developed by Sun Corporation. Java describes applications by using class libraries in much the same way that C++ does. Java is quickly spreading in the field of programming and is expected to support 3-D graphics in the near future. We built our 3-D physical simulation environment as a Java application, instead of using C++, to make it more portable and architecturally neutral. Consequently, when a new version of the application is released, only the class objects constituting the new parts of the application will need to be downloaded to the client site instead of replacing all the binary file.

3.2. Java object structure

We have defined five kinds of Java class objects in order to achieve a more extensible and interactive 3-D simulation environment. Because Java class objects are defined independently of each other, users can easily define new environments, simulation engines, and interactions between 3-D objects by creating a new Java class object inheriting and combining the basic class objects. Each Java class object for describing a simulation can be used with any viewer that supports the Java application program interface (API).

1) Class to define a viewer.
2) Class to define environmental properties.
3) Class to define 3-D object properties.
4) Class to define simulation engines.
5) Class to describe interactions between 3-D objects, such as collision detection.

We will describe these five kinds of classes in detail in the following.

1) Viewer: We defined a "Viewer" class to display 3-D objects from the users' viewpoint. Methods in the "Viewer" class are implemented as native methods using the WorldToolKit [Sence8, 1993] C library for visualizing 3-D graphics because Java does not yet support 3-D graphics library. The WorldToolKit C library has task functions, to realize simulation in a 3-D space, that can be connected to individual 3-D graphic objects and can be defined by users. However, the simulation is limited when using only these task functions because the WorldToolKit is a C library. A more extensible simulation environment can be created using Java. When a Java 3-D graphics library is released, we will redefine the "Viewer" class to use it; the viewer can then be a Java applet downloadable and executable on a World Wide Web browser.

*2) **Environmental properties:*** We defined a "SimulationEnv" class to encapsulate the variables for the environmental properties: *gravity, simulation start time, current time, previous time*. This "SimulationEnv" class encapsulates only gravity in the current version. The "Viewer" class is defined as a subclass of the "SimulationEnv" class, so it inherits the environmental properties. The values of the environmental properties are set as default values when the viewer is generated, but can be changed by users interactively.

*3) **Properties of Simulated 3D object:*** We defined a "Simulated3DObject" class to contain the 3-D object properties needed for physical simulation: *mass, resiliency factor, previous/current position, previous/current orientation, previous/current velocity, previous/current acceleration* . Each property has a default value that is set by users interactively.

*4) **Simulation engine:*** A simulation engine is defined as a behavior class. In our first implementation, we simulate 3-D objects falling in a gravitational world. The simulation engine classes are instanced within the block of the 3-D object class. A simulation engine is activated by invoking "start()", which is a method of the simulation engine class with an argument of start time. The Viewer has a timer and calls the "simulate()" method of 3-D objects with arguments of previous time and current time. The "simulate()" method of a 3-D object runs the simulation engines. A simulation engine calculates the current position, orientation, velocity, and acceleration in each direction of the 3-D object and returns the values. The simulation engine classes can thus be used in other viewers that support Java API. The 3-D object is set to the correct position and orientation according to the values returned from the simulation engine. The engine ignores interactions with other 3-D objects, such as collisions. Collision detection is checked by another class object. We have initially implemented the "Fall" class, which simulates the motion of falling.

*5) **Interaction between 3-D objects:*** Collisions are the main interaction between 3-D objects in the physical simulation environment. A class object is therefore needed to describe the motion of 3-D objects before and after collisions with each other. We have defined classes to describe interactions between 3-D objects as follows:

- The "DetectCollision" class is defined to check if two objects collide with each other.
- The "KeepEnergy" class is used to calculate the velocity, position, and orientation of each object after the moment of collision. There are two cases for two 3-D objects colliding:

  (1) Both objects can move, such as "ball".

  (2) One can move and one is static, such as "ball and floor".

  The 3-D objects are checked for their ability to move, and the results are returned to the calculation.
- The "CollectCollidingObject" class is for collecting the position and orientation of each object after colliding with another object. First, the position, orientation, and velocity of each object after the moment of collision are calculated by the "KeepEnergy" class object. Then the current position, orientation, and velocity of each 3-D object are calculated and the values for the 3-D objects are set accordingly.

The classes for describing interactions between 3-D objects are called within the "Viewer" class. The 3-D objects to be checked are selected by the users before starting a 3-D physical simulation experiment, and the classes check on only the selected objects.

3.3. Example simulation experiment

Based on the classes we have defined, the motions in a gravitational environment are as follows:

- Motion of falling ball.
- Motion of ball bouncing on a floor.
- Motion of two balls colliding with each other.

Users can experiment by changing the properties of the 3-D objects, such as the resiliency factor, initial velocity, and initial position, and also the environmental property (gravity).

3.4. Reusability and extensibility

In the current version, the simulation environment has only gravity as an environmental property. The environment can be easily extended by adding other properties (air resistance, electrostatic fields, and so on) that inherit the basic class object we defined as "SimulationEnv". By combining the classes of interactions between 3-D objects, various simulations can be run. They can be also reused to create a new class of interactions between 3-D objects.

4. Conclusion

We presented a method for achieving an extensive and interactive 3-D physical simulation environment in a virtual world using the Java language. In the application we developed, learners can conduct simple 3-D physical simulation experiments. The "Viewer" class has a native method using the WorldToolKit C library. In the future, the "Viewer" will be definable by a Java 3-D graphics library, and then the simulation environment can be constructed as a Java applet. We are planning to implement a 3-D physical simulation environment in a shared virtual space.

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Cross-age Tutoring as Cognitive Apprenticeship

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Abstract: Collaborative learning, particular peer tutoring, involves learners in a process of inquiry through discussion or tutoring, and promotes inquiry and produces the effect of learning. The goal of this study is to verify this assumption. As an inquiry depends on what kind of question is generated, it is necessary to consider how learners generate productive questions. The approach taken in this study is to examine learners' inquiry in the aspect of question. The following analysis will show that the students' technique of inquiry is developed by the near tutors' suggestions. That is, cross-peer tutoring involves students in a process of inquiry through tutoring. The tutors aid this process by the "cognitive apprenticeship" approach.

1 Introduction

Learning theory has changed from "transferring knowledge" such as in a traditional education system to "having an interactive relationship with one's surrounding environments including others." In order to learn, learners have to think out what they do and then do it by themselves or through an interactive relationship with one's surrounding environment without instruction. Under this perspective, learning is a problem-centred inquiry by learners through social interaction. That is, a learner must have or develop the technique of inquiry.

There is an argument for the importance of making students inquire(Dewey, 1963). Students should develop the technique of inquiry. However it is difficult to promote learners inquiry because the technique of inquiry can only be developed by inquiring.

Recently the idea that peer interaction fosters learning has been widely accepted. Various kinds of practical studies have been examined, and many studies provide positive results of collaborative learning and peer-tutoring. However, much less attention has been given to when and why collaborative learning produces this positive effect.

Chan argued that effectual collaborative learning might be limited without the understanding of knowledge as problematic and as requiring explanation, and showed the efficacy of problem-centred inquiry in collaborative learning using a psychological experiment(Chan 1996.) Collaborative learning, particular peer tutoring, involves learners in a process of inquiry through discussion or tutoring, and the situation promotes inquiry and produces the effect of learning.

The goal of this study is to verify this assumption. As an inquiry depends on what kind of questions are generated, it is necessary to consider how learners generate productive questions. The approach taken in this study is to examine learners' inquiry and to find out what kind of questions are generated.

2 Peer-tutoring through computer network

We had to design a collaborative learning situation and record verbal interactions to find out the process of inquiry. For these two aims we designed a cross-age community through a computer network with intent to produce a peer-tutoring scenario.There is some research which shows that tutoring, especially cross-tutoring gives students the opportunity to learn activity through their own questions. Students ask more questions during tutoring than in classroom situations. We used BBS (Bulletin Board Services) under the computer network to help record all questions and answers during the peer-tutoring. The cross-age community consisted of junior students and senior students from different academic departments at different locations.

For the learning task, junior students, who were computer novices, learned basic computer concepts under the tutelage of senior students. Novices often have great difficulty mastering new domains. It is accepted that a better way to acquire a new domain is by tutoring.

3 Outline of the experimental curriculum

The course "Computer and Life" was presented to 34 junior colleges in 13 lessons (100 hours). The students in the department Art had no computer literacy and had no knowledge about HTML (HyperText Markup Language).

The 13 lessons were broken down as follows:

Lesson1: Students learn the basic computer operation functions.
Lesson 2-4: Students learn basic wordprocessing.
Lesson 5-13: Students learn HTML and create a Web Page.

Students were divided into nine groups consisting of an average of four students. Each group was assigned to two specific tasks. The first task was to research, using reference books and dictionaries, a new concept in computer science which is RAM(Random access Memory), ROM(Read-only Memory), and so on. The second task was to create a Web page to explain their interpretation of the new concepts. Requesting and engagement in explanation have been shown to play a central role in successful group learning performances.(Webb, et al. 1995, Miyake 1986, Chan 1996.)

In this way, unless students had much understanding of the concept in the first task, they were not able to use it effectively and efficiently in the second task. As mentioned earlier, there was the possibility that a student might need tutoring as they worked on their own. If that was the case, students could seek for assistance, using BBS, from senior students in the department of Engineering.

The easy-to-use BBS has a simple two-page structure. The dialogue is based on a simple strategy, starting with a question followed by a possible answer.

4 Kinds of interaction

The interacton in 8 lessons for two months was saved in the BBS. The analysis showed the questions' transition caused by the senior tutors.

At the beginning of the lessons for creating Web pages, the students were at a loss because of unknown concepts. Almost all students sent out vague questions on BBS such as "I do not know about a SCSI(Small Computer Systems Interface). Please teach me about it.". The first time when the seniors responded to a vague question, they provided a detail explanation. After they read many vague questions, they transferred their responses to "Before asking such questions, look it up for yourself." or "You should ask a question after first making it clear to yourself." They replied with suggestions based on their experiences. These suggestions had some effect as seen when some juniors then asked questions after first looking up the terminology in a dictionary or in a textbook, which were later discussed in the group. The vague questions were transformed into concrete questions.

In regard to concrete questions, the students asked for the confirmation of what he/she had interpreted and then the senior students provided a basic confirmation - either correctness or incorrectness. Some junior students presented examples to confirm their interpretation. For instance, "I suppose that all information is represented as one or zero. If so, is hiragana or katakana represented as one or zero?" Students who ask confirming questions tended to explain more accurately and in a more structured way than those who simply asked vague questions repeatedly.

With time, some senior students responded "You should inquire in detail" continued with a brief explanation. After this, the questions on BBS decreased.

5 Conclusion

The above mentioned analysis shows that the students' inquiry techniques were developed by the near tutors' suggestions. That is, cross-peer tutoring involved students in a process of inquiry through tutoring. The tutors suggestions were based on a "cognitive apprenticeship" approach. This involves modeling, coaching and fading. Advising what word to look up in a dictionary, helping them confirm their explanation, and then fading the help as they take on more responsibility.

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The Development of a Virtual Factory Teaching System

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Abstract

Recent efforts in manufacturing education have been aimed at developing more integrative and technology-based learning approaches which facilitate student teamwork. The Virtual Factory Teaching System (VFTS) addresses the educational needs of new and potential engineering students by creating a manufacturing education workspace that will exist in the intersection of the three domains of education, the Internet and virtual factories. The workspace takes advantage of advanced communication technologies in presenting manufacturing complexities to engineering, business, and other students interested in factory dynamics. It features a virtual factory teaching system (VFTS) accessible via the World Wide Web. University instructors will use this workspace to illustrate the concepts of factory management and design as applied in a realistic setting. The design of the workspace will enable students to participate in the functioning of the virtual factory by assuming the roles of various factory personnel in small team settings. Through acting out these roles, they will witness the range of decisions an engineer or a manager makes and their effect on the performance of a company. The VFTS will also be implemented in other educational venues, including K-12 schools in the Los Angeles area.

Background

The literature and research from the domains of education, the Internet, and virtual factories indicate the potential for developing a Virtual Factory Teaching System (VFTS). Numerous studies describe the usefulness of computer-based learning tools in classroom instruction. Various tools have been designed specifically for courses in engineering and the hard sciences. The manufacturing program places emphasis on information technology; for example, network teaching and research tools are being developed to study the complexity of supply chains.

The VFTS is designed not only to promote holistic understanding; but it should also facilitate student teamwork. Engineers and managers must learn how to function well on "virtual teams" that may span continents. Learning to work as a team member has additional pedagogical benefits for students beyond simply preparing them for future careers. It has been found that students working in collaborative groups have been better able to formulate concrete ideas and avoid misconceptions.

Virtual enterprises are considered key to re-configurable, computer-networked business structures that can find high-value, innovative solutions customized to customers needs. Corporations that use such concepts will require individuals who understand the complex dynamics of manufacturing processes. The VFTS will provide a platform for this training. The major benefit of a virtual factory is that physical system components (such as equipment and materials) as well as conceptual system components (e.g., process plans and equipment schedules) can be easily represented through the creation of virtual plant entities that emulate their structure and function. These entities can be added to or removed from the virtual plan as necessary with minimal impact on other system data. The software entities of the virtual plant have a high correspondence with real system components, thereby lending validity to simulations carried out in the virtual system meant to aid decision-makers in the real one.

The Project

This project addresses the educational needs of new and potential engineering students by creating a manufacturing education workspace that will exist in the intersection of the three domains of education, the Internet, and virtual factories. The workspace will take advantage of advanced communication technologies in presenting manufacturing complexities to engineering, business, and other students interested in factory dynamics. It will feature a virtual factory teaching system (VFTS) accessible via the World Wide Web. University instructors will be able to use this workspace to illustrate the concepts of factory management and design as applied in a realistic setting. The design of the workspace will enable students to participate in the functioning of the virtual factory by assuming the roles of various factory personnel in small team settings. Through acting out these roles, they will witness the range of decisions an engineer or a manager makes and their effect on the performance of a company. Student teams may even span institutional boundaries.

This project is divided into a series of evolutionary phases, beginning with the development of a baseline VFTS in the first year. The baseline VFTS will include all the major components that are deemed central to the theme of a virtual factory when used as an engineering education workspace. It will serve as a prototype for a full-scale model, which will be enhanced to address a broader range of student interests (e.g., with finance modules for use in business courses) as well as engineering needs (e.g., with capabilities for handling greater complexity and variety of manufacturing processes). The baseline VFTS will be implemented in engineering courses in the second phase. In the third phase, evaluations of the baseline VFTS will serve to drive system modifications. At this time, the VFTS will also be implemented in other educational venues, including K-12 schools in the Los Angeles area.

Our study proposes a creative solution to the problems posed in trying to physically replicate complex manufacturing environments by combining real site visits with virtual factory modeling and simulation. Opportunities unfold in the areas of inter-university collaboration that could span the country and the world, giving students valuable experience in long-distance collaboration on technical projects, while facilitating teaching and research efforts among students and faculty.

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The Canadian Visual Arts Information Network Student Interactive Imaging Program

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Introduction

Cultural information can have significant added value when it is shared and re-used rather than being re-collected in different forms by various organizations. A central electronic source of reliable, up-to-date visual arts information reduces duplication and the need to collect and verify the same information more than once.

Canadian Visual Arts Information Network

The Centre for Contemporary Canadian Art (CCCA) was founded as a not-for-profit, charitable arts organization and operates as a flexible, accessible resource working for the benefit of artists, the arts community and the public at large. The CCCA seeks to excite the public about contemporary Canadian art by increasing their exposure to information about artists and their work, and believes that an integrated approach to information gathering and dissemination is the best method to achieve this objective.

The CCCA has set out to accomplish these goals by establishing *The Canadian Visual Arts Information Network (CCCAnet)* which is based on a national Visual Arts Database and Directory. The key to the database is in its comprehensive, reliable, up-to-date information about Canadian artists and their work.

Canadian Visual Arts Database and Directory

The Database is based on the *Multi MIMSY 2000* Information Management System developed by Willoughby Associates of Winnetka, Illinois. It already includes a Visual Arts Directory of over 2,000 entries (including more than 1,200 artists; over 400 public galleries and artist-run centres, art dealers, art consultants, and other visual art professionals and organizations). It also includes over 1,200 digitized works of art of more than 100 artists, and information on more than 100 contemporary art exhibitions and publications. More information and images of artists' work are regularly being added to the database as the material is received from artists.

The focus of the CCCA Database is on contemporary Canadian artists and their work. It contains detailed biographical information on individual artists; digitized images of their work in public, private and personal collections; bibliographic references; artists' statements; and will soon include audio and video clips of some of the artists speaking about and making their art.

Student Interactive Imaging Program

To build the database, the CCCA has initiated the *Student Interactive Imaging Program* by developing a partnership with Confederation High School in Nepean, Ontario. Under this program, students are involved in the digitization of 35mm slides from artists; galleries and other visual arts organizations; entering the images and related information into the CCCA Database; and in the design, construction and maintenance of CCCAnet.

Learning Benefits

As a learning activity, both the development and the use of the Canadian Visual Arts Information Network is a rich, multi-faceted environment that promotes many effective learning principles. CCCAnet has been designed to be an interactive learning web site that connects contemporary Canadian visual artists and their work to people throughout the world. In addition to publishing and promoting the artists' work the site is designed to allow students to interact with practising artists in order to enhance their involvement in, and understanding of, visual arts. This "expert/student" relationship is extremely important in the formation and development of understanding of the arts, but is often difficult to establish in schools. The evolving web technology makes this relationship possible.

Students who worked on the design and development of the web site not only acquired the knowledge and skills required for web page construction but also for the first time had a meaningful relationship with professional artists and their work. The knowledge that their expertise and work on this project would contribute to the appreciation of Canadian art around the world inspired the students to produce a quality product.

Dissemination

By compiling and making available a large, up-to-date bank of information, the CCCA seeks to give the visual arts a greater overall 'presence' by providing meaningful Canadian visual arts content to the arts community, universities, schools and libraries, and to the general public across Canada and abroad over the CCCAnet web site <http://www.ccca.ca>.

Canada's SchoolNet

The CCCA is working with SchoolNet to help disseminate CCCAnet to schools across the country. *SchoolNet* is a federal initiative in collaboration with provincial/territorial ministries of education to help connect all 16,500 schools (including all 417 First Nations schools under federal jurisdiction), and 3,400 public libraries across Canada to the Information Highway. *SchoolNet Digital Collections* is an innovative Industry Canada program designed to give Canadians 15 to 30 years of age entreprenurial and technology-based job experience converting collections of material into digital form for display on SchoolNet. Teams of young people work with businesses, institutions and other organizations to make a wealth of largely undiscovered Canadian material accessible on the Information Highway. This program has assisted the CCCA in engaging students to develop CCCAnet.

Distance Learning

The Centre for Contemporary Canadian Art is also working with the Ottawa-Carleton Research Institute (OCRI) and U.ACT Incorporated of Gloucester, Ontario, to develop further interactive methods of disseminating cultural information from the Canadian Visual Arts Information Network across Canada and around the world. The CCCA is currently experimenting with interactive software designed and developed at the Multimedia Communications Research Laboratory (MCRLab) at the University of Ottawa. JETS is a Java-enabled 'TeleCollaboration System' designed for the real-time sharing of Java applets. Using any Java-enabled Web browser, multiple users in a telecollaboration session are able to share generic applications in the form of Java applets

Conclusion

The learning environment provided by the Canadian Visual Arts Information Network and the Student Interactive Imaging Program is dynamic and continually evolving as new works and text are added to the database and as additional interaction takes place. It represents a learning opportunity that can be revisited many times. By using the tools of technology to facilitate student/artist dialogue, therefore, it is hoped that more youth will become actively engaged in the visual arts in a variety of ways.

Acknowledgements

This paper was written with the collaboration of John A. Spence, Principal and Don McCahill, Administration Head, Confederation High School, Nepean, Ontario.

Perspectives on Structure: Approaches to Structured Course Development for Multi-Mode Delivery

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Abstract: This presentation outlines a structured course development and delivery strategy in development aimed at facilitating a learning environment that can be delivered in a variety of delivery formats. This strategy aims at breaking away from linear course development models towards a dynamic, ongoing, group-oriented model through the use of Standard Generalized Markup Language (SGML). Insights into the process of prototyping such a strategy in the context of developing a high school Information Technology course will be offered.

One of the core challenges for those who aim to support distance education is that of creating curriculum-relevant learning environments that facilitate engaged learning. Another is the need to be able to meet a set of learning outcomes using multiple modes of delivery and interaction. These challenges can be met with an approach that balances the need for structured content management with the immersion of the learner in the material.

This presentation describes a structured course development and delivery strategy aimed at facilitating a mediated, collaborative learning environment that can be delivered in a variety of formats: on the Internet, in print, on CD-ROM. The outcome of the process is a set of structured content modules that exist *independent of output format*, but which can be easily moved into particular delivery media on demand. Considering output format separately means an audience of students can approach and interact with course materials in ways appropriate to their specific needs.

At the core of this strategy is SGML *(Standard Generalized Markup Language)*, an ISO standard for describing structured content. Anyone who has authored WWW pages is familiar with at least the face of SGML; HTML *(HyperText Markup Language)* is a specific *document type* instance of SGML. However, whereas HTML has evolved into a sort of online typesetting language, the larger sphere of SGML offers powerful and flexible options for describing electronic documents according to their content-inherent attributes.

Such a system ultimately allows for group authoring, easy updating, rapid re-purposing, and publication of materials to multiple delivery media. Format, presentation, and interface become *a function of* the structure of the content, rather than defining it. The goal in development is to produce and organize multi-dimensional content and to be able to facilitate its delivery in an ongoing fashion.

The course development process revolves around the creation and maintenance of a central set of structured (marked-up) documents in a clean, non-output-specific form which can thus be easily accessed, edited, revised, and worked on by a team of course authors, instructional designers, delivery specialists, teachers, and facilitators. Our aim is to break away from linear, discrete course development and revision models and to embrace a groupware strategy that keeps material alive and current through development and delivery.

At the writing stage, course materials will have relatively little structure; the material is written either as plain text or styled word processor documents. The next stage of the process sees the content evolve into a highly structured "clean implementation" phase. Here, content is encoded and arranged in a highly defined file structure, using *Adobe FrameMaker+SGML* as a core development engine. At this point, decisions about publication options can be made. These include not only not delivery format decisions (Web, print, or other), but also course delivery considerations such as mediation, access, and other logistics of instructional design.

The course material itself takes the form of "short-branching hypertext," which is multi-dimensional and polyvocal while remaining generally linear. On screen, sub-topics, time-sensitive material, and other perspectives pop up in subwindows or are set into existing pages without taking away from the central linear thread. In print, subtopics occupy traditional layout devices such as sidebars, pull-quotes, and footnotes. The finished product presents a number of voices and points of view in a single visual field.

Further to this is an idea we hold in high esteem: that a course—whether delivered electronically or in print—exists in a larger context, drawing upon larger themes, dialogues, and threads. We feel that a structured development and delivery environment can include or at least facilitate links to the a variety of hypermedia forms, be they external texts, interactive pieces, conferencing and discussion areas, or other, yet-to-be-realized media. By developing in a structured way it becomes possible to embrace a standard scheme for referring to external elements.

We hope also to be able to share this strategy and model with other courseware developers. This project is very much based on open systems and simple, non-proprietary tools. We are interested in developing successful strategies rather than "solutions".

The process is being prototyped as the development and delivery model for the *Information Technology 11* course offered this year by the Open Learning Agency's New Directions in Distance Learning (NDDL) program.

The Open Learning Agency is a public non-profit agency specializing in the delivery of distance education and training through the innovative use of a variety of technologies. The OLA is funded by the Government of British Columbia and by grants, tuition fees, sales, donations, sponsorships, and partnerships. It is headquartered in Burnaby, British Columbia, Canada.

A Web-based Framework for the Complete Integration of Teaching Concepts and Media in Computer Graphics Education

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Abstract: Topics within computer graphics still cannot be adequately presented and explored with traditional teaching methodologies and tools. An integrative approach to combine lectures, examples, programming exercises, documentation etc. is greatly needed, this supported by a common sophisticated interface.

At our Lab we developed a computer graphics course that focuses on this need. The practical part of the course consists of Java-based example programs and exercises on the computer in which the students can test the theoretical concepts and generate their own experiences.

The integration of the different theoretical and practical parts of the course is realized through a common Web-based interface to the system. The main objective is to support the students in gaining an insight into the research methods and experimentation processes that occur in the development of new graphics techniques.

(*Note:* A more detailed version of this short paper can be found in the corresponding ED-MEDIA'97 CD-ROM Proceedings.)

Introduction

The topics *visualization* and *interaction* belong to the major parts of the area of Computer Graphics. Nevertheless, these issues cannot be adequately presented for educational purposes solely with traditional teaching methodologies and tools, such as blackboards, slides, and even videos. The general problem seems to be that the students do not gain any insight into the research methods and experimentation that actually occur in the development of new graphics techniques. Such an insight can only be provided through the incorporation of experimental methodologies into computer graphics courses.

Nowadays, Java provides an excellent software platform to solve the problems mentioned above through its platform-independency and the support of shared and distributed objects that provide the means to allow students to collaborate with each other and their tutors and to complete and explore the programming exercises at home (on their PC's).

The Course

The first experiences were collected throughout two consecutive computer graphics courses which contain the basic parts of computer graphics. The courses have been tailored to students of computer science and contain a variety of programming assignments. In its current form the courses are not well suited e.g. for engineering students: Such students prefer a course where they can learn how to use commercially available packages instead of having to invest too much time in programming examples of basic computer graphics algorithms.

The course contains the following topics: Computer graphics hardware, raster algorithms with aliasing and anti-aliasing, 3D-transformations, visibility, color, local illumination schemes, modeling techniques, simple animation, texture mapping, global illumination techniques (ray-tracing, radiosity), and volume visualization.

The programming exercises are done in groups of two or three students using the Java-based programming environment. The Java source code of the environment is available on a ftp-server for different platforms and can be downloaded by the students. A comprehensive written instruction is available for each exercise in the form of HTML-pages. For each programming exercise, a small example program for which the source code can be downloaded as well gives a short introduction into the topic. The exercise itself is widely pre-programmed; the students have to fill-in the parts that are left blank for the assignment. The source code of the exercises is also accessible through the Web, thus allowing for permanent switching between the theoretical background information, the description of the exercises, and the source code of the latter. The aim is to support the students during the completion of their programming tasks.

Via hyperlinks to parts of the script in postscript format, the students can review the theoretical background for every single exercise.

The Java-based Programming and Experimentation Environment

The programming environment is the crucial part of our concept, since it is the basis for examples as well as for the programming exercises.

The new generation of 3D software tools is *object-based* and such tools are composed of extensible sets of 3D objects, objects for interaction purposes, objects for transformations, objects which represent materials, etc. Therefore, we integrated object-oriented ideas into our system as used in these packages. This way our students get familiar with the concepts of modern graphics systems and up-to-date object-oriented graphics programming through the usage of our system.

Object-oriented programming is also suitable to provide the user with a set of basic objects. Geometrical objects like points, lines, etc. are implemented as own classes with own methods and can be re-used for different applications.

As mentioned above, the documentation in form of Web-based hypermedia information allows for repeated switching between the theoretical background information, the description of the exercises, the source code of the latter, and more, thus supporting the students during the completion of their programming tasks. In addition, the understanding of class hierarchies can be tremendously increased through nested hypermedia documentation.

Conclusions and Future Work

The Java-based version of the programming environment [WSI/GRIS, 1996/97] has been applied to two consecutive semesters of the computer graphics course held at our department in 1996/97; an earlier version to two consecutive semesters in 1995/96 [1].

Independently from the evaluation of questionnaires that were handed out, we were able to discover some remarkable effects of our course: In comparison with courses held in earlier years and covering the same topics of computer graphics, less students quit after successfully completing the first course and did not participate in the second (20 % in 1996/97 and 30 % in 1995/96 compared to 45 % in 1994/95 and 50 % in 1993/94). From the students that successfully completed the second course, many more were immediately involved in current projects at the Lab in form of programming activities such as practical courses and B.Sc. and M.Sc. theses (30 % in 1996/97 compared to 20 % in 1995 and 20 % in 1994). We noticed that several students started to add non-requested features and functionalities to the system after having gotten familiar with it.

Future work includes the integration of VRML2.0 to allow for the realization and use of more complex scenes and for the support of collaborativeIn order to serve with our course a larger, inhomogeneous community of people interested in computer graphics, future research has to face questions of adaptive user-interfaces based on first experiences and promising results made in our group in this area.

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[1] This version was not yet Java-based but realized the same concepts on the basis of a self-developed, platform-independent C++ programming environment [WSI/GRIS, 1995/96]

USING VIDEOVOICE IN A PRONUNCIATION COURSE IN FRENCH AS A SECOND LANGUAGE

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Abstract: The multimedia technology is now well established in most classrooms and language labs all over North America, creating a new world of possibilities for teachers of pronunciation in French as a second language since it brings resources that were previously unavailable to the language classroom. Now that advanced speech recognition systems are no longer restricted to research facilities and are commonly and more affordably available commercially, they bring with them new tools to help the second language learner hear and pronounce phonetic and phonological features. This speech communication is about one of these new tools, VideoVoice, developped by Micro Video, and about how it can be put to use in a pronunciation course in French as a second language.

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VIDEOVOICE

VideoVoice was developped by Micro Video as an aid in speech therapy. It is designed to be used in a face-to-face situation by therapists to help young children with various pathological problems. It is quite innovative in that it allows the user to have a visual feedback of his utterances, be they isolated sounds or entire phrases, via an easy-to-read visual display. The system also allows for immediate comparison between a model utterance and its imitation [Fig.1]. Another interesting features of VideoVoice is the extensive use of video arcade style games.

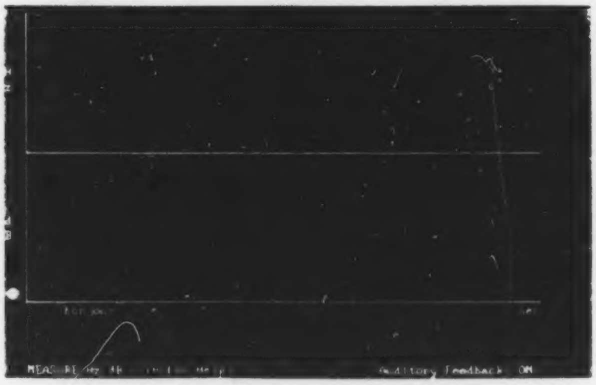

Figure 1: visual display created by VideoVoice

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ADAPTING VIDEOVOICE TO A LANGUAGE CLASSROOM SITUATION

I have been experimenting with VideoVoice in my pronunciation course since January. I have chosen to use it as a tool to teach and learn intonation patterns (pitch), because it offers different ways to display intonation patterns. The Temporal Display shows model patterns as well as students' trials on a full or split screen, with the same time frame. There are also a number of games which can be used to encourage practice. For example, Pitch Painting: a varied pitch will paint the screen a wide range of different colours, whereas a flat intonation will paint the screen one or two colours only [Fig. 2]. With Hickory Dickory Clock, another pitch- oriented game, the student's rising or falling pitch makes the mouse run up or down the tower.

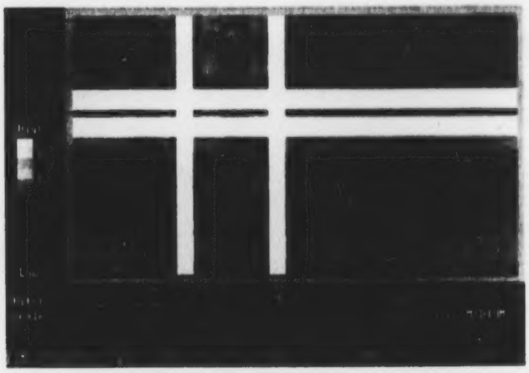

Figure 2: a varied pitch will paint the screen a wide range of different colours

I have designed a VideoVoice-based learning program for my students. Since VideoVoice has an Assessment/ Report Menu, keeping track of the students' progress should be an easy task. The computer will keep track of the number of trials and the scores for each model, and give a detailed report on the student's progress from session to session. I will be able to report on the students'progress shortly.

FACING THE TECHNICAL CHALLENGES

VideoVoice was designed to be used in a face-to-face situation by therapists to help young children with various pathological problems. Adjusting the program to a language learning context brings about a series of challenges. First of all, VideoVoice was not designed to be networked: a card must be installed in the computer hard drive, and it cannot be shared. Likewise, a filter box has to be plugged into the computer, and cannot be shared either. Buying more than one program is a costly option: the complete VideoVoice package sells for 3 000 US$. Consequently, the computer on which VideoVoice is installed must either be a stand-alone computer or be set apart from the network via a special program to be designed by the network technician. Minor network-related annoyances are the default labels (Patient, Therapist, Clinic) which cannot be permanently changed to the other available labels (Student, Teacher, University). Also, with a network, nothing can be stored on the hard drive. As a result, students have to work from individual floppies, which limits the quantity of material that can be stored and affects the speed at which models are retrieved.

Other problems are: the keyboard: the default layout being US keyboard, it is therefore impossible to have all those funny little things that are essential to French -accents, cedillas, and tremas; the system does not support laser printers; some sound cards are not supported either. However, despite all this, using VideoVoice in the French language classroom does benefit the students, as the first results of my experiment seem to indicate.

"Do Computers Belong in a Museum?"
Providing Public Access to Information Technology in a Museum. An Australian Perspective.

By Allan Kreuiter MSc (Sci Comm) Powerhouse Museum, Australia

Abstract Programs and exhibitions at the Powerhouse Museum of Applied Arts and Sciences (MAAS) have demonstrated by the response that they generate that there is a strong interest in Information Technology in Australia. Schools also have indicated that recent proposals to put an internet access in every school in the state and the
fact that we have the second highest relative use of the internet after the USA mean that they a strong interest in doing programs in IT as part of an integrated visit to a museum.

The focus of this paper is that a museum based access for IT must address these two areas of IT and museum culture, in order to create programs that fulfil the needs of its audience to enlightenment and demystifying of the negatives and positives of Information Technology.

Is there a role for museums in educating and giving access to the public within a Museum? The Powerhouse responds to these needs by developing a specific area called the ITC (for Information Technology Centre).The ITC works with both education and public groups to foster public awareness of and access to IT. It does this by using cutting edge educational software and commercial IT applications as part of divers styles of visits integrated with MAAS museum access.

Of particular interest has been the development of visit packages specifically for design and fashion groups to interact with recent software developments and combine with museum displays of designers work. This integration with museums and material culture has also been successful in fields such as history of computers, language use training and creative writing.

Have they succeeded or have they simply created a Computer "pocket" isolated from museum activities that does not fully integrate with the exhibitions or address the real needs of the general public nor museum visitor.

I want you to imagine the computer that is on your desk at home, or beside you now. Is it the same computer as the one you were using last year? How about 5 years ago? Did you even own a computer 10 years ago? How different is the software you use and the way that you use it. This is the dilemma that faces museums using and displaying IT today.
Computers are so much a fabric of our visitor's existence that as well as showing the history of computer technology museums must respond to current developments to reflect both society and future changes that will strongly influence the lives of our clientele. This must show the possibilities inherent in such technology as well as its positives and negatives
Is this possible and how can it be done?

Interest in Science and Technology

Before continuing with this idea I should deal with the assumption that there is a need for such education about computers. Is there an interest and how is it expressed?. Leaving aside such anecdotal evidence as the response of our visitors, there are three chief indicators that there is an interest: Internet connections, attendance at shows and surveys.
Australia has the second highest rate of internet connection per household; whether or not this interest will continue to grow or not is another matter but it certainly demonstrates significant trends in interest. Computer shows and expo's have vast audiences, and if we add in the computer games market this is expands even more. Thirdly a survey of American households (SCIENCE & ENGINEERING INDICATORS - 1996) states that 40 % of all surveyed expressed a high interest in science discoveries and the use of new technologies, while only 10% thought that they were actually well informed about such issues)
Finally all the schools in our State have plans to be connected to the internet by the end of 1997, since education groups are a major market of ours this is almost sufficient reason on its own.

Powerhouse Solutions

The Powerhouse Museum responded to this need in a number of ways, first it created an exhibition of computers from Babbage to IBM. Next it built the Information Technology Centre to create a place for growing vibrant computers in a museum.
The first is a case of a static museum display that reflects museum culture. It covers important areas for students and visitors like the history of computers and simple demonstrations. But there is a limit to the amount of exposure to Information Technology that can happen, as the average visitor looks at an exhibit for less that 10 seconds.
A solution that may prove to be the most effective use of computers in a museum is the creation of an area dedicated to computer power that can be accessed by the visitor with the aid of fascilitators, the Information Technology Centre. In many cases computers are too limited in their flexibility to the general public. Thus education on their possibilities is

limited to either demonstrations, which are disappointing to most, or to the expertise already existing within the visitor. The ITC answers this gap by planning education groups with cutting edge software, or general visitors with a short training and exposure to newer developments. Thus general visitors with no experience but great interest in the Internet would be shown the software and with a fast link and computers be led through some simple tasks to expose them to the possibilities of the medium.

Alternatively a design group may visit the ITC and be trained in the use of a specific set of tools and then guided though a design brief related to their study. They could use CAD principles to design a chess piece and cut it out on a CAM lathe, or use digital camera and manipulate images, and then create a poster based on inspiration received in a visit to the another exhibition within the museum whether it be IT or fashion or visual art.

The ITC however works with both education and public groups to foster public awareness of and access to IT. It does this by using cutting edge educational software and commercial IT applications as part of divers styles of visits integrated with MAAS museum access. What this means is general visitors are exposed to new software that shows the importance and relevance of it to their life, and education groups are connected with the curriculum to allow teachers to justify visits doing this sort of education based activity and to use it in future work in their classroom.

Two other innovations increase the value of this centre. Pre and post visit events especially ones found on the web site have been shown to greatly enhance the understanding and enjoyment of visitor groups[Follette RL 1987] . These do not have to be computer related to add value to the visit eg the design of a dress on paper by a class with allow them to understand the advantages (and limitations) of doing so on a computer. The second innovation is the concept of connection to exhibitions. Use of an exhibition combined with use of the ITC establishes a connection between the two, a connection that can easily become a divide between a computer centre and the museum it is based within.

Community Interaction

The sort activities based in an ITC can be seen to be strongly empowering community groups in IT, thus allowing the museum to reach much more of the public than would normally be approached. For example the ITC runs events for unemployed youth group which are a combination of training and phobia reduction for these disadvantages groups. It does not attempt to replace structured training but it may allow the visitors to approach such training without disadvantage, or at least show them some future possibilities in their lives. Other ideas include encouraging retired groups to visit in a thing called Cybersurfing for beginners using a promise of fast links, cheap rates and above all personal interaction. It has been found that this certainty of having a keen knowledgeable source able to respond to questions constantly present was an antidote to the "impersonal intimidations" of Information Technology.

Criteria for a working Computer space

Computer demonstrations are most successful when they follow the Socretean Principle " What I hear I forget, what I see I remember, What I do I understand" To promote understanding in visitors computers have to be interactive in a meaningful way. Partly so the possibilities of the system are remembered, and partly to empower and encourage visitors to tackle the questions and implications of a computer literate society. A danger is also that the interactives become toys and this is where a constant reference to museum culture and the social implications of IT is important to emphasise.

You need tools that show the possibilities of the future that can be used today, good examples are digital cameras and interactive telescopes. At the same time the envelope must be pushed to show future possibilities, things like 3D simulations and Waldo remote applications or running an on line telescope have great potential to excite people in asking questions and having interactions with IT.

Have we succeeded?

Have they succeeded or have they simply created a Computer "pocket" isolated from museum activities that does not fully integrate with the exhibitions or address the real needs of the general public nor museum visitor. Our interest levels remain high, we were booked out last year and are getting so again, and the response from teachers and students has been enthusiastic. The isolation will always be there in part, computers have to have some cages for security and some conditions for their care and feeding, but the computer "petting zoo" should encourage all visitors to loose their fear of the dangerous beasts, and maybe allow others to see their fragile beauty in a new light.

This is the question that will have to be answered by both time and by the responses of our visitors, perhaps we shall only know when in a year our inspired visitors return, or in 20 years when a computer literate generation brings its next generation to visit the ITC.

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LEGO-Logic: Developing Scientific and Technology Thinking

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Abstract: LEGO-Logic is a learning environment developed to integrate creative construction of concrete machines and models with an introduction to computerized processes control. LEGO-Logic was developed at the IDEA[1] Center, to facilitate the learning of both scientific concepts and their technological applications. Through the suggested type of learning the student not only learns about science, but also practices science. In this way, he or she learns, not only abstract scientific and technological principles, but about scientific and technology processes as well. With appropriate guidance and direction, the LEGO-Logic environment enables the learners to build their knowledge through varied, rich experience.

The qualification of learners to live in a technological world, will be evident in their ability to efficiently utilize technology, use existing technology to plan and manufacture new products, and think of directions to develop new technologies. Thus, learning technology has to involve two main activities: using technology and developing new technologies. Understanding the nature of technology and its influence on human life is essential for the development of curriculum for Technology and Science Education.

Curriculum Development Based on the "Spiral Model"

In order to study the interrelations between technology and human beings and to realize its influence on the development of society, a theoretical model called "The Spiral Model of Technology Evolution", was used (Krumholtz, 96; 97). The "Spiral Model" describes the interrelations among four factors: human needs, physical phenomena, technological constraints and technological solutions.

We suggest an educational approach for teaching science and technology that allows the learner to experience technological activities and technological processes. A technological process includes the identification and separation of all four factors in the "Spiral Model". The learning experience in a technological process starts with identifying a problem - an human need - and ends with raising, choosing and producing a solution - a practical product. Science and technology learning is inherent to the overall learning process when the learner tries to deal with technological problems and to overcome physical constrains.

The Learning Environment

In order to give the learner the opportunity to go through a process similar to the process of developing a technological product in real life, we have to choose a simulation system suitable to the learner. That is, it has to be easy to use, close to the content of the child's world of interest and suited to his or her level of development. Moreover, in order to teach scientific and technological concepts and principles in a way that will lead the learner from intuitive understanding of the concepts to a more formal, scientific understanding, it is necessary to provide the learner with a wide range of concrete experiences using simple models and familiar tools.

We found that LEGO DACTA computer control systems: LEGO-Logo and the later development ControLab, meets these requirements. They can be used in classes as "Micro-Worlds" that the kids can operate in (Resnick, 1993). We developed learning activities that allow the learners to experience technological processes and physical phenomena. Through the activities learners gain practical experience in planning, constructing and operating physical models that are computer controlled. The learners are building models from LEGO bricks, including motors, lights and sensors and using the computer to control the operation of the models. Such models are for example, traffic-lights that simulate real operation, greenhouses that open and close doors according to the temperature inside the greenhouse, remote controlled wheelchairs, washing machines, conveyer belts that identify boxes according to size or color, elevators, racing cars, etc.

The Learning Process

Following the five stages of development of technological products, we suggest that the children go through five stages in the learning process and become both users and developers of technology:

1. Learn about human needs - identify one need or demand.
2. Plan and design a solution - suggest a LEGO model that will provide an answer to this need.
3. Carry out the plan - build the LEGO model and program the computer to control the model's operation.
4. Market the product - exhibit the product in the classroom.
5. Suggest future developments - for your LEGO model to respond to new demands it may trigger.

Advantages and Difficulties

The LEGO-Logo learning environment was used with various groups of learners, both school children aged 9 to 15 and teachers of elementary and junior high school. Based on our experience we found that:
LEGO Models - the LEGO DACTA computer controlled models answer our needs for a simulation system which can help deal with the technological world. We realized that the LEGO bricks and the variety of products, allow us to choose different models for the different populations. The great variety of LEGO models and building elements, made it possible to define an evolving line of models with increasing levels of complexity.

Control Software - Working with the programming software TC-Logo and later with the ControLab software, we identified some basic difficulties:

1. It takes time to master a formal computer language, in this case the Logo language.
2. For young and novice learners the programming language is too complex, even without considering time limit.
3. Israeli children are not familiar with the English language and this poses the greatest obstacle for young learners.

We realized the need to have a programming software that:

- Keeps the powerful ideas of Logo programming, such as structured programming, simple recursion, closed-loop and open-loop control.
- Is easy-to-use in relation to the ability of the user.
- Is user friendly, for example, contains commands which are represented as icons and not as words.
- Has on line detailed help screens, to allow inquiry and self learning.
- Does not require any previous experience in computers.

We defined the concept for a programming software that in cooperation with a software-firm in Israel was developed under the name of *TechnoLogica* (TechnoLogica, 95).

LEGO-Logic - The New Learning Environment

TechnoLogica software, the LEGO models and the learning activities and processes based on our educational approach, composed a new learning environment called *"LEGO-Logic"*. For the teaching of technology we chose to emphasize the role of the logic of the control structures, defined by using *TechnoLogica*, rather than programming based on formal computer language. Therefore, *TechnoLogica* was developed as an icon based software that permits the user to define various control structures (IF, IF-ELSE, WAITUNTIL, REPEAT) without the need to use any formal programming language.
TechnoLogica allows three modes of control:

1. Immediate mode of *manual control*.
2. *Automatic Control*: Open-loop control, executing a list of commands.
3. *Feedback Control*: Closed-loop control, using sensors for feedback.

To let the learners experience an instance of technological evolution, the models are first operated manually. Then, a motor and batteries are added to operate the model by electricity. At these stages the learner operates the models in on/off operations, under manual control.

At a more advanced stage, the model is connected to a computer and is automatically operated, controlled by *TechnoLogica* procedures, programmed by the learner. In the final stage, sensors are used to enable feedback in the control loop.

In the final exhibition, which is part of the marketing phase, each participant raises suggestions for further development of the product, that may satisfy new needs that will be triggered through the use of their model.

The more advanced stage is when the motor is used and a procedure is programmed to operate the model. This operation is called an open-loop control or an *automatic* operation.

In the last stage a light sensor is attached to the elevator and it allows for *feedback* control, when the light sensor "sees" each floor and the computer "tells" the motor to wait for 3 seconds, before going on to the next floor.

The future developments for this elevator model, that are suggested by the learner, are based on the need for safety that arises when the elevator is used. Another light sensor could be used to "see" if there are people standing in the way to prevent the movement of the elevator door. Another possible development consists in the elevator "seeing" if there are at all people who actually want to stop in each floor.

Research Results

LEGO-Logo and LEGO-Logic were tested with different groups of learners of different ages and with different needs: average learners aged 8 to 14 in a special research setting and in normal class settings; gifted kids aged 6-8 and 13-14; learners at the age of 12-14 with learning difficulties

One of the studies engaged three groups of 7th and 8th grade learners that went through the process of developing a technological product according to the learning process that was described above (Krumholtz, et al., 93). The analysis shows that physical concepts such as, speed, acceleration, static and dynamic friction, gravity, force and balance were involved and that most learners (87%) had reached intuitive understanding of the concepts. Some of the learners (24%) expressed more formal scientific understanding of the concepts.

The study that had been conducted with learners with learning difficulties, revealed that the learners had reached an intuitive understanding of the above mentioned technology phenomena, to some extent (Krumholtz and Zodik, 1993). What was most significant in their experience, as was expressed by them at the end of the learning period, was the chance they had been given to create something of their own - a solution which they invented. Their expressions of creativity ranged from merely inventing a name to a given model, to suggesting various new operations to its function, and for some of them to building their own mechanical model.

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[1] The **IDEA Center** headed by the author, is involved in the past eight years in research, development and implementation within the fields of Technology and Scientific education. The specialty of the center is the development and implementation of innovative learning environments which use computer technology to enhance learning and teaching, for example, Logo, LEGO-Logo, LEGO-Logic and Media+.

An Evaluation of a Web-Based Distributed Learning Environment for Higher Education

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Abstract: The multimedia model employed in this project is an attempt to produce cost-effective instruction for the world-wide web by building upon audio and visual material captured in the classroom. This research compared the effectiveness of a multimedia Web course with conventional classroom learning under a controlled experimental design and found no difference in student performance.

Course Design

An introductory course in MSU's Telecommunication Department, TC100 Introduction to the Information Society, is the focus of the research. It uses Straubhaar and LaRose (1997) as its basic text. The course was previously delivered on campus in lecture halls with 100 to 300 students. A set of Web pages were created from lecture outlines in the textbook's Instructor's Manual. Links to Web sites that provided appropriate visual aids were added. The Web pages and the links were presented live in the on-campus lecture course during fall term, 1996. Small groups of students sat at the front of each class and responded to questions posed by the instructor. Thus, the give and take of a small classroom setting was adapted to a large lecture course. The classroom audio was recorded.

A Web site featuring the same course outlines, web links and review quizzes seen by students in class was designed by MSU's Communication Technology Laboratory. The classroom audio was linked to the appropriate pages on the course outline which the user controlled with a Real Audio player. The external links were automatically launched at the appropriate points. In short, the interface amounted to a "talking course outline" which faithfully captured the original classroom interactions.

Procedure

The completed web pages were posted on MSU's Web server with password protection so that only students enrolled in "virtual TC100" for spring term 1997 could view them. Students for "virtual TC100" were randomly selected at the start of the term from a pool of volunteers from two on-campus lecture sections of TC100. Students not selected to participate in the "virtual" course were the control group and continued in their on-campus lecture sections, where the same web pages and links shown in class the previous semester were once again used by the instructors on campus. Students accessed the pages through public computer labs or personal computers in their residences.

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Student progress was monitored via student log-ins and by having learners submit written answers to review quizzes on a regular basis. Email accounts and chat rooms were provided to facilitate communication with the instructor and to distribute course-related announcements. Samples of the course materials may be found at http://www.msu.edu/virtualu/tc100.

Results

For this preliminary report, the grades on the first examination were compared between the experimental (web course) and the control (classroom) groups. The exam consisted of seventy-five four-choice, multiple choice items. It was administered to both groups on printed paper forms, although the experimental group entered their answers into a web form while control students used conventional mark-sensing sheets in their classrooms.

The experimental group had a slightly higher mean score (**x**=54.66, sd=9.52) than the control group (**x**=53.2, sd=8.68) although the two means were not significantly different (t=.46, p=>.05).

Discussion

Thus, we conclude that "virtual TC100" is equally as effective as the classroom version. As of the first examination we did not confirm Schutte's (1997) finding that web courses are *more* effective than their classroom counterparts, although our data did show a tendency in that direction. However, it is important to note that the results of the initial exam may reflect the difficulty many of the virtual (experimental) students had in accessing the web materials and navigating through them. On-campus labs were not made readily available as had been promised, and a number of students apparently failed to realize that they needed to click on "next" to reach subsequent pages in each lecture. Thus, the experimental group may very well exceed the control group after all the results are in.

Implications

This course could serve as a model for Web course preparation which captures the sights and sounds of real classroom interaction with minimal additional effort and expense, at least once the initial delivery platform is created. As such, it raises the possibility of creating multimedia Web courses within the parameters of conventional teaching and teaching assistant assignments. The same multimedia "shell" will be adapted to other courses, taught by other instructors, simply by recording classroom audio and posting Web page versions of overhead transparencies. Unlike Schutte (1997) the course does not have to be consumed in "real time" and can be re-used over several semesters. This could radically alter the economics of multimedia course preparation, putting them within the ken of all instructors, not just multimedia specialists, and make it possible to offer small-scale courses as well as large ones, realizing the ideal of a "Web major."

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On-line Interactive Educational Multimedia via Residential Broadband Wireless Access

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Abstract: Internet delivered on-line multimedia education is likely to develop into a major mechanism for the provision of off-campus education. It is envisaged that students will access on-line educational services via a broadband internet network accessible from the home. We describe network architectural models for such a scenario, and propose a 'study process' model appropriate for on-line multimedia education. We then consider issues of the resulting data traffic in the links to the clients, for this link is typically the bottleneck. Assuming that wireless access will be cost effective and provide desired mobility, we examine the impact on the educational process in which this access to the home is via broadband wireless taps into a broadband fibre / cable network.

1. Introduction

In on-line education, a student uses a personal computer to access an educational server computer, the latter typically located at a university. The student learns by working through the material downloaded from the university computer, interacting with educational software executing on the student's PC, experiencing information presentation, simulations, tutorials, and tests (formative and possibly summative). Examples of tomorrow's On-line Multimedia Education (OLME) can be found in today's high quality educational CDs (eg [Ryan 97]), for student exposure to the latter will set the market expectations [Sykes & Sewell 96].

In this paper we examine some of the issues involved in how the finite capacities of telecommunications networks will impinge on such internet delivered on-line multimedia education.

2.0. Internet Delivered On-line Multimedia Education

We consider the scenario in which students work at home, accessing their on-line courseware via a broadband network as in Figure 1.

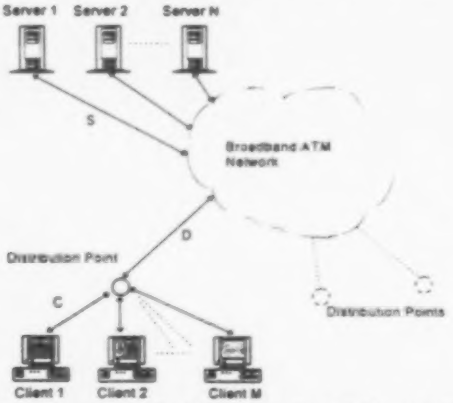

Figure 1. Architecture of Residential On-line Multimedia Education.

Students (1...M) work at personal computers, learning by executing OLME software (the courseware), which has been downloaded from the OLME servers, 1 ... N. Students obtain rights of access (passwords) to the courseware by enrolling in courses / subjects.

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The S and D links of Figure 1 will typically be provided on high capacity Asynchronous Transfer Mode (ATM) fibre networks, which are economic in such highly shared links. The C links however serve only one client, and so will normally not be fibre, due to cost considerations. Thus the C links will typically be of limited capacity and may involve shared media with a joint capacity limit, eg as in broadband wireless [Celidonio & Di-Zenobio 96] or hybrid fibre coax trees [Sykes & Sewell 96]. The capacity limitations of the C links, and the characteristics of ATM networks at high traffic loads, must therefore be considered in the design of OLME for such internet delivery. In addition to the OLME traffic, and not shown in Figure 1, are all the other services that the ATM network will also be conveying. Thus, as well as the OLME traffic, there will be various multi-service, multimedia, multi-client traffic flowing through the ATM network, and the latter will sometimes impact on the OLME services, and vice versa.

'Doing a subject' consists of working through a number of 'Modules' and each such module consists of a number of 'Interactive Screens'. Thus we model the data transmission involved in such internet delivered OLME as bursts, described in three levels of timing diagram (see figure on CDROM), involving 'Download Data Bursts', 'Lessons', and 'Study Sittings'. The *Download Data Bursts (DDBs)* are short bursts of data which are sent to the client, corresponding to one (usually) interactive screen, which the student then interacts with to learn. The *Lessons* are periods over which the student learns a topic by interacting with a series of interactive screens, where each screen is downloaded when the student requires it, in the sequence specified by the student and/or the supervisory software; thus multiple DDBs constitute one lesson. A *Study Sitting* is the period of time that a student spends 'connected' to a server, before switching off the computer or disconnecting the communications link.

3. Transmission Considerations

The Client (C) links in Figure 1 may be wireless, using a limited capacity technology such as Local Multipoint Distribution Service, relying on statistical multiplexing to support high numbers of users, and various multimedia services, eg OLME, Video on Demand (VoD) and Telephony [Lockwood & Everitt 96]. Thus as well as users competing for bits, the various multimedia services will also be competing. Most significant may be VOD, which will be conveyed in the form of Variable Bit Rate or Constant Bit Rate ATM cells, and with a Quality of Service constraint that delivery be not subject to excessive jitter. Thus at the instants when the instantaneous traffic demands on the distribution point are high, VoD traffic may have priority over OLME traffic, effectively introducing significant delay and delay variation into the OLME DDBs.

4. Conclusions

We have described a scenario in which on-line multimedia education is delivered to students at home, via a broadband wireless link. We have proposed a data transmission model for such OLME, which is very bursty. We have illustrated how the transmission network and other non-OLME multimedia services can impact on user satisfaction (and in the CDROM version have suggested various strategies to cope with these impacts). We have begun to characterise the nature of the OLME and VoD traffic at the distribution points, and the OLME throughput to individual Clients, assuming wireless ATM C links. The aim is to clarify the issues and quantify the tradeoffs, to inform the design and implementation of on-line multimedia education.

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A Virtual Schoolhouse for Educational Resources

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Education reform is "raising the bar" for educators with challenging standards, new teaching and assessment methods and increased accountability. Technology is expected to play a key role in aiding reform. It is expected that the Internet will play an integral role in classrooms of the future. However, connecting schools to the Internet is only part of the challenge. Another part is to provide teachers and students with resources they can use in the classroom. As the amount of content available over the Internet multiplies, there will be an increasing need for teachers to find places where they can go "one stop shopping" for educational materials. The present paper describes a "virtual schoolhouse" which we are developing to serve teachers and students. The virtual schoolhouse is designed to be a repository of resources that would normally be found in a physical schoolhouse, but without the constraint that they be located within the school.

It is expected that the Internet will play an important role in the future of education. According to the American Association of School Administrators, 65% of U.S. schools have Internet access already. New schools continually connect to the Internet and educational content is created and added to the Internet daily.

As this proliferation of Internet resources continues, with anyone being allowed both to create and use content, we must not lose sight of two objectives: there must be organization to the material available and there must be quality control. One cannot simply send students and teachers into cyberspace and hope that they will find educational material that is both relevant and of high quality. Even the advent of web browsers are insufficient. For example, we entered the topic "high school science" in a popular web search engine. It returned approximately 1,000,000 matches. We then focused the search on "high school physics". A full 400,000 matches were found. The search was focused even more on "Newton's Laws". This produced a match of 10,000 responses.

We argue that such numbers will only increase as more and more people add content to the world wide web. We do not believe teachers will spend the time surfing the information superhighway looking for educational content. What is needed are organized resources in cyberspace much the way there are organized resources such as libraries, research centers and schoolhouses in physical space. These organized resources would be places on the Internet where teachers and students could go for "one-stop-shopping" and gain access to materials and activities relevant to their teaching objectives.

Research Development Corporation is currently developing a virtual schoolhouse. The goal of the virtual schoolhouse is to be a repository of educational resources for students and teachers. These could be in the form of educational research articles, curriculum materials, educational games, simulated laboratories and forums for exchange of ideas. The goal is to provide the same types of resources found in an actual schoolhouse, but without the constraint that educational resources, students, and teachers be collocated at the same place at the same time.

When completed, the virtual schoolhouse will have the following components. First, there will be a virtual library where teachers and students can read educational research findings, commentary and other relevant educational publications. The virtual library will be a place where teachers can post and download curriculum materials so that these can be shared by all teachers.

Second, there will be a chat room, where teachers can discuss educational issues in real time. The goal of this is to give teachers access to a wider range of professionals than they might find within their own schoolhouse. In our previous research (Leddo, 1995), we found that one of the biggest needs cited by teachers for their own professional development is more interaction with other teachers and related professionals.

Third, there will be a lecture hall where teachers and students can attend, at a distance, professional development lectures. We envision both real time and asynchronous modes of presentations in three forms of presentation: text, audio and video. In cases where presentations are real time, we envision teachers and students having the opportunity for "live" question and answer sessions with the presenter. Where presentations are done asynchronously (i.e., prepared ahead of time and broadcast at specified times), teachers would either have to e-mail their questions in advance or send them after the presentation for subsequent response.

The virtual schoolhouse can be augmented even further. One of the challenges developers of cyberspace learning environments face is making these environments user-friendly. A physical library is not only organized, but has a reference librarian who can answer questions, direct a teacher to relevant materials, etc. What makes a reference librarian effective is not just knowledge of the resources in the library, but the ability to understand the needs of the teacher and asks relevant questions in order to reach that understanding. We believe the virtual schoolhouse should have the same sorts of "intelligence", namely a virtual reference librarian in the form of an intelligent agent that serves a similar role.

In order to address these issues, we will present a discussion of ongoing research in several related projects. First, we are constructing a virtual schoolhouse architecture that is designed to support simulation-based learning activities with integrated intelligent agents. This architecture will support collaborative problem solving over the Internet so that students at different sites can work together. The first simulation to appear in the virtual schoolhouse will have intelligent tutoring so that students can receive remediation as part of the learning experience.

Second, we are developing intelligent agent technology to be included in the virtual schoolhouse. These agents are primarily designed to serve as co-problem solvers as they work. Agents can serve in both an instructional and assessment capacity through their dialog with students. This is discussed in greater detail in our second paper submission: "Internet-based intelligent tutoring games".

We are also serving as a repository for research papers, position papers and other reference material that might be useful to teachers.

Acknowledgments

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Internet-based Intelligent Tutoring Games

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Educators wish students had the same interest in learning academic subjects as they do in playing computer games. Developing computer games that are entertaining, yet educational, pose technical challenges. These include developing a game environment that supports the subject matter being taught, assessing student learning from game-playing behaviors, and having game events respond to individual student learning needs. The present paper describes work to develop an Internet-based game to teach scientific reasoning. The game context is solving detective problems. Detective work is chosen for its similarity to the scientific method. Assessment of student learning is accomplished by having game characters converse with players to probe their reasoning. The scenes in the game teach different aspects of scientific reasoning. The activities and information present in these scenes are driven by student learning needs.

A Framework for Intelligent Tutoring Games.

The goal of our work is to embed high quality instruction in the context of computer games so that students can learn in a fun environment. This presents the challenge of creating games that are as fun as those that would compete for students' learning time, yet present meaningful instruction. Because our emphasis is on education, we focused on that aspect first and built the game around it.

The first step in our project was to develop a model of scientific knowledge. Since our goal is not simply to present a science curriculum within the context of a computer game but rather to build the same type of thinking skills in students that scientists have, it is important to identify those skills. Based on discussions with research scientists, we extracted the following process of scientific inquiry.

The process of scientific inquiry begins with a question. The question directs subsequent inquiries, the results of which will be evaluated according to how well they address the question. The second step is to develop a model of the phenomenon in question. Very often, scientists cannot directly observe the phenomenon they are investigating. As a result, scientists develop models that represent their best approximation of the phenomenon. Often, investigations look for ways to test these models. The third step is to develop hypotheses that represent possible answers to the question. These hypotheses must have observable consequences, and the observable consequences of different hypotheses must be different. The fourth step is to collect data or evidence to distinguish among the explanations or hypotheses being considered. This step is a key discriminator between successful and unsuccessful investigators. Effective information gathering requires understanding what types of information discriminate among the hypotheses, and knowing how to collect this information. The fifth step is to analyze the data in order to come up with results that would be relevant to the hypotheses under consideration. This requires not only knowledge of the mechanics of analysis methods, but also the ability to select an appropriate analysis method for the problem at hand. The final step is drawing conclusions about the hypotheses in the light of the evidence collected. This involves determining which hypotheses are best supported by the evidence and whether that support is strong enough to draw a definite conclusion.

Once we established the concepts we wanted to teach students, we selected a game context. Our goal was to pick a context that lent itself well to both a game and the subject matter. We chose solving detective stories given the parallel between how scientists and detectives think. The table below illustrates this parallel.

Scientific Reasoning	Detective Reasoning
Formulate a question	Who "dunnit"?
Develop hypotheses or models to answer question	Find suspects, develop scenarios about how crime was committed
Gather information related to hypotheses	Collect clues
Compare measurements to predictions of hypotheses	Forensics; comparison of clues to scenario predictions
Draw conclusions	"Beyond reasonable doubt"

Table 1: Scientific Reasoning vs. Detective Reasoning

Based on the above analysis, we can create detective stories that make teaching points regarding scientific reasoning. For example, we can create stories with multiple suspects to teach students how to gather evidence that will distinguish which is the guilty one. This is analogous to having multiple hypotheses that a scientist must collect data for in order to distinguish which one is likely to be correct. We can manipulate the number of clues or their reliability in order to make teaching points about how it is important to collect sufficient data and how biased data can distort one's conclusions.

An Internet-based Intelligent Tutoring Game

A prototype of an intelligent tutoring game has been developed and placed on the world wide web (WWW). It can be accessed at http://www.RDCPublishing.com. In the game, the student joins a team to solve a mystery. The teammates serve as co-problem solvers as well as mentors when the student needs instruction.

The game is written in hypertext markup language (html). The student views each screen and then clicks a forward or backwards arrow to move through the story. At several points in the story line, the student is asked to make decisions. These could either be decisions with respect to what path to follow in solving the mystery or to perform quantitative problem solving. The choices the student makes will influence what path the story takes. In the cases where students are asked to solve problems, their answers are used to assess whether they need any remedial instruction. In cases, where remedial instruction is provided, students follow a separate branch of instructional activities off the main story line. Upon completion of the remedial activities, they join the main story line in the place they left off. The student then follows the story line to its completion or until additional remediation is needed. By the time the student reaches the end of the storyline, s/he will have completed the enter lesson embedded in the story as well as any remediation that was required along the way.

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EDUNET Global Learning Resources Development Project: What We Learned from Creating Our Homepage with Others' Web Resources

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Abstract: To date, most global resources on the Internet have rarely been of practical value to Korean schools and learning communities. This is due to the fact that they are in English or other commonly used foreign languages and reflect cultures and curriculum that are quite different from those of Korea. The EDUNET Global Learning Resources Development Project was launched in June 1996 in order to create an open environment which promotes accessing and using valuable global resources. The homepage developed in the project provides a variety of learning and instructional resources selected and slightly modified from resources on other web sites around the world. Based on the experiences of the current project, the following is suggested for ensuring better quality service development: (1) Long-term and comprehensive initial development plan, (2) Responses to dynamic and evolving features of the Web, (3) Management for obtaining copyright release, and (4) Management system for quality translation.

Introduction

The Internet has transfigured the images of both learning time and learning spaces by expanding the walls of traditional classrooms out to the global world. It has significant potential for creating a new educational system through the establishment of learner-centered, open learning environment [Lee 1995; Lee 1996]. To date, however, the majority of global resources on the Internet have rarely been of practical value to Korean schools and learning communities. This is due to the fact that they are in English or other commonly used foreign languages and reflect cultures and curriculum that are quite different from those of Korea. Due to those differences, the teachers and students have experienced difficulties accessing and using valuable global resources.

Overview of the EDUNET Global Learning Resources Development Project

The EDUNET Global Learning Resources Development Project was launched in June 1996 with a budget of roughly $ 130,000, and ended its first development in December of the same year. The homepage developed in the current project provides a variety of learning and instructional resources selected and slightly modified from resources on other web sites around the world. The resources embody lesson plans and learning resources in the primary subject areas at each school level. They cover various media formats, including text, image, graphic, audio, animation, and video. There are 207 resources listed in the homepage as of December of 1996.

Strategies for Quality Web Resources Creation using Culturally and Linguistically Different Web Resources

Based on the accumulated experiences stemming from this Global Learning Resources development process, the following strategies for ensuring higher quality service development from culturally and linguistically different Web resources are suggested:

1. Long-term and comprehensive initial development plan

Comprehensive planning at the outset is very important for having a total picture of the development budget and timline. General steps to be considered in the planning include: needs analysis, curriculum analysis & sample Web sites analysis, Web resources selection & copyright release acquisition, related data download & translation, digitalization & remaking all data into HTML. First and foremost, a development team should arrive at a clear and shared consensus on whom perspective users are and the specifications and extent of which subjects should be served.

2. Responses to dynamic and evolving features of the Web

Metamorphic features of the Web. Most Web sites are periodically revised either in their contents or structures. Modification or elimination of original Web sites imply potentially serious problems in generating time and financial loss. Considering this nature of the web as well as a never-short remakes cycle, one realistic solution is to download all original sources at the outset and keep them until translation is finished.

Interactive features of the Web. Web sites increasingly provide interactive services such as form, discussion, feedback, user-directed activities and so on. For now, it appears a challenge to provide original site's feedback in a local server corresponding to user's input for two reasons: One relates to a technical issue, the other to experts. Responding to user's input will require additional efforts in programming such as software solutions like CGI at a local site. In addition, it requires a local site to retain content experts capable of responding to user's input. Without ensuring those solutions, interactive features at original sites inevitably will be lost at local sites.

Hypertextual features of the Web. Due to differences in cultures, not all information at other web sites would be beneficial for local users. Instead, partial use of a web site is recommended. For this case, special attention should be paid on fluent reconnection among relevant hyper-linked parts. In addition, many instructional phrases, icons, and directions may need to be deleted or revised to make sense.

3. Management system for obtaining copyright release

It is a time-consuming and labor intensive process to obtain a copyright release. Well-organized and continuous management is a must to contact copyright owners and comprehend the correspondence contents. Among other management responsibilities: it is necessary to keep recording for on-time and efficient communication, and to maintain serious reviews of correspondence.

4. Management system for quality translation

Acceptable quality translation of resources is the eventual factor which decide the quality of local web sites. However, many subject matter experts such as school teachers, lack advanced skills in English translation; expert translators do not have knowledge in specific subject areas. The quality of any resources, however, will primarily depend on the quality of translation. Therefore, we need to establish a management system that will ensure the cooperation of experts in subject and translation.

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THE INFORMATION WARFARE MULTIMEDIA AID

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ABSTRACT

A multimedia CD ROM and Web-based version of the "Information Warfare Multimedia Aid" have been developed at the US Army War College. This tutorial is geared for introducing the concepts, points of view, and players involved in defense-related information warfare. In designing this system, some interesting features were incorporated into this aid. This paper discusses these special features that other multimedia designers may want to include in their systems.

1.0 Description of the "Information Warfare Multimedia Aid"

"Information warfare" is considered one of the biggest threats in today's and tomorrow's society. In order to better acclimate senior leaders to the issues, weapons, countermeasures, and points of view relating to information warfare, the Information Warfare Multimedia Aid (both CD ROM and Web version) was developed and circulated to key individuals and organizations in the U.S. (Liebowitz, 1996). This program was developed in six months using Authorware Professional 3.0 as the multimedia authoring language. The program used a leading expert in information warfare as the content specialist. The program consists of ten modules discussing introductory concepts, threats, weapons, political issues, defense-related perspectives, recommendations, and conclusions. Video segments, hypertext, sounds, voiceovers, graphics, and animation are used in the system.

2.0 Useful Features in the Information Warfare Multimedia Aid

2.1 Tailored Modules

The Information Warfare Multimedia Aid uses tailored navigation to recommend which modules, and in what detail, would be best for the user to review. The system asks a series of questions, based upon the user's background and interests, at the beginning of the user session. Accordingly, the recommended module names are underlined in red in the table of contents and once the modules are reviewed, the module names are highlighted in green.

2.2 Cases and Vignettes

In order to better understand future implications of information warfare activities, cases and vignettes have been included in the Information Warfare Multimedia Aid. The cases and vignettes enhance the conceptual material and reinforce the issues in a realistic way.

2.3 Interactive Exercises

A variety of interactive exercises have been included at the end of each module, if the user wants to "test his/her knowledge." Every exercise gives the user two tries to get the correct answer, and then the correct answer is highlighted with a brief explanation of why each response is right or not. At the end of the module post-test, a score is computed with a graphic representation of the number of correct and incorrect responses.

2.4 Annotated References

A list of close to fifty references with associated brief descriptions have been provided in the "Reference" section of the Information Warfare Multimedia Aid.

2.5 Glossary

The Information Warfare Multimedia Aid contains a glossary that can be accessed any time to get definitions of words, acronym meanings, and points of contact at different agencies. The glossary also contains a "find" feature to locate words in the glossary.

2.6 Excel Appendix

An Excel executable which can be invoked in the Information Warfare Multimedia Aid contains organizational charts of companies and agencies performing information warfare work.

2.7 Quick Question/Answer Expert Advisor

Another value-added feature incorporated into the Information Warfare Multimedia Aid is an expert system quick question/answer advisor on information warfare. This component was built using Exsys Professional as the expert system shell. It can be invoked any time, and allows the user to get quick, informative answers to questions about information warfare.

2.8 Executive Summaries

Executive summaries of each module are included in the system. The summaries are concise and give excellent overviews of the salient points in each module. There is a "print" feature to print out the summaries in case the users want to review them at their leisure.

2.9 Voiceovers with Highlighted Text

The Information Warfare Multimedia Aid is rich with voiceovers with highlighted text used throughout the tutorial.

3.0 Summary

The initial feedback of the Information Warfare Multimedia Aid has been very positive, especially with the value-added special features discussed in this paper. These features have certainly enhanced the multimedia system, and other multimedia designers should strongly consider incorporating such features in their systems.

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High School Students as Multimedia Designers: An Experience

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Abstract: This presentation reports the authors' experience in engaging high school students as multimedia designers in a simulated multimedia production house for the second year. It describes the multimedia design model used, its implementation and the evaluation of students-created multimedia products.

Theoretical Perspective

For centuries, learning by doing has been perceived and used as an effective instruction model. It has been used in a variety of disciplines with success [Collins, Brown, & Newman, 1989]. The recent advancement in interactive multimedia/hypermedia technology has demystified the technology in such a way that it makes it possible for learners, elementary or high school students, English or computer science majors to have the power of designing multimedia programs and be a multimedia developer. Literature and research have shown that engaging learners as designers of multimedia programs has the benefit of not only enhancing their motivation but also promoting their higher order thinking skills [Lehrer, Erickson, & Connell, 1994; Perkins, 1986]. Being a multimedia designer, a learner is given the opportunity to research, design, and create. A number of studies on the topic have shown some preliminary success [Carver, Lehrer, Connell, & Erickson, 1992; Lehrer, 1993; Liu & Rutledge, 1996].

Multimedia Learning Environment

High School Students

This experience of engaging high school students as multimedia designers occurred during the Fall 95 and Spring 96 semesters. The participants were from an inner-city minority dominant high school in a Southwest city. They were twenty-six 10th-12th graders enrolled in a multimedia design class (Caucasian = 29%, Hispanics = 52%, African American = 10%, other = 9%). About 60% of the school population are considered to be at-risk for not finishing high school.

Multimedia Design Model and Its Implementation

This multimedia course is a year-long one. It uses a four-phase design model [Liu & Rutledge, 1996]. It includes (1) planning, (2) design, (3) production, and (4) evaluation and revision, based upon the practice used in the multimedia industry [McDaniel & Liu, 1996]. The first semester focused on learning the basics of multimedia design and various tools. They started with simpler multimedia programs and then moved to more complicated multimedia software. Students completed most assignments on an individual basis. During the second semester, while students continued to learn multimedia tools, the focus of learning shifted to collaborative work. Students were given the opportunity to work with a client and design for a real audience. After several brainstorming sessions, students formed groups of their own interest and proceeded to work collaboratively. One group worked with Texas Parks and Wildlife department to create a multimedia kiosk. One group worked with a university graduate in creating children programs using original songs. Two other groups chose to work on a poet story and a football program. Each member of the team was assigned a role of a researcher, graphic artist, programmer, project manager, or animator for their project. They were engaged in creating storyboards, researching, and producing the programs. They learned the state-of-art multimedia tools. Three people from Texas Parks and Wildlife department and one graduate student worked closely with two teams. The teacher acted as the project manager for the entire class and provided guidance especially to the other two groups. During the semester, students made trips to local multimedia companies, made presentations at a multimedia users group meeting and had local multimedia experts visited the classroom. Several factors characterized this environment. The design process was made explicit through (1) direct instruction by the teacher, (2) interaction with local multimedia experts, and (3) assessment used. Student learning was scaffolded by (1) explicit design instruction, (2) learning multimedia tools, (3) coaching by the teacher, the peer (the more experienced students), as well as the clients.

Students met as a class for one hour and half everyday for a total of eighteen weeks per semester. They had accessed to five Power Macintosh computers, two Mac LCIIIs, two Mac 575s, and one Mac 520. A PowerMac with video digitizing and editing capability was acquired in the second semester, but was no longer used after its tape deck was damaged. Seven of these computers had adequate RAM and disk space for using software like Photoshop, Premiere and Director. One PowerMac with sufficient computing power was assigned to each group. Students in the group, therefore, had to take turns to use this computer.

Technical Skills Acquired and Multimedia Programs Created

At the end of the year, all students had a good command of Claris Works, SuperPaint, HyperCard used in the course. Some students were very proficient in Adobe Photoshop, and Adobe Premiere while others were good at Macromedia Director. In addition, students used Ofoto for scanning, and SoundEdit 16 for audio digitizing and editing. One group used Strata Studio Pro, a sophisticated 3D rendering program extensively. Students' command of the multimedia tools was reflected in their ability to explain various features of their programs, such as the choices of media, fonts, metaphors, and their ability to demonstrate how to execute certain techniques during the presentation at the end of the year. Their competence with the multimedia tools was also reflected in the four programs they created. Students created: (1) a multimedia kiosk for a park, which provides text, video, and graphic information about birds, snakes, mammals, endangered species and plants in the park; (2) a children's program which used five stanzas of the song "I wanna be a dog" to teach vocabulary through animation; (3) an Edgar Allen Poe program, which presented Poe's poems and a story in a 3D environment; and (4) an NFL football program. It is worth noting that although some video clips were supplied by the clients, students created most of the graphics, audio, and video from scratch. The clients and the teacher were very satisfied with what the students accomplished within the time frame. The clients especially were "really impressed" with students' work and expressed their desire to continue working with the class.

Students' created multimedia projects were demonstrated and discussed. The experience of engaging high school students as multimedia designers and lessons learned from this experience were shared in detail.

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The Provision of an Open Access CAL Resource Base.

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Abstract

Cardiff School of Engineering has recently appointed a dedicated Teaching and Learning Technology Support Officer. This has resulted in a unified resource base which has been implemented for open access and has required the development of a generic front end system to enable the inter-operability of CAL tools with differing / conflicting software requirements.

This paper outlines the development of the resource base and reports on the problems encountered in this process. The paper introduces recommendations for the future development of academic CAL material designed for open provision.

Background

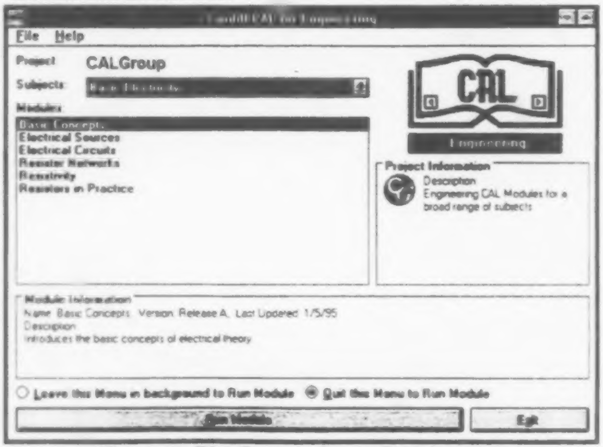
The UK has benefited enormously from the Teaching and Learning Technology Programme (TLTP), whose projects have involved consortia of Universities producing CAL material to cover a wide spectrum of subjects. TLTP material must be made available to all UK HE institutions at distribution cost. TLTP therefore represents a major source of academically validated CAL material. To the funding councils however, TLTP represents a substantial investment. Clearly both the funding councils and the institutions expect to see a measurable return on this investment.

The Cardiff School of Engineering is a member of a TLTP Engineering project and as such has contributed [1,2,3] to the development of 60 CAL modules covering a range of engineering subjects. The current project, 'The Cardiff CAL for Engineering Project', continues the School's involvement in CAL. The project is based upon the School's need to utilise CAL to enhance teaching quality and learning, meeting demands for the effective utilisation of technology and providing support for staff wishing to embed CAL within courses.

The primary objective of this project is therefore to implement a resource base of suitable CAL material for use in the School's teaching and to encourage the uptake of material by staff and students. To achieve this, the key activity is to establish an open access CAL resource base, supported by a range of facilitation initiatives, which include a CAL newsletter, a WWW site and support workshops and lectures.

The CAL Resource Base

The resource base will comprise all appropriate TLTP material, material from other academic sources as well as suitable commercial material. Initially only PC based material has been considered. This is to ensure that the depth and the scope of material is developed quickly, to enable fast and effective utilisation and that the material provided originates from validated sources. Also, all material must be run on a standard platform and accessed from PC based file servers. The current resource base consists of a range of software, covering such diverse areas as Mathematics, Materials and Electronics.



Project CALGroup
Subjects: Basic Electricity
Modules:
Basic Concepts
Electrical Sources
Electrical Circuits
Resistor Networks
Resistivity
Resistors in Practice

Project Information
Description
Engineering CAL Modules for a broad range of subjects

Module Information
Name: Basic Concepts. Version: Release A. Last Updated: 1/5/95
Description
Introduces the basic concepts of electrical theory

○ Leave this Menu in background to Run Module ● Quit this Menu to Run Module

Figure 1: The Generic Front-End System.

Integrating the CAL Packages

The lack of development standards and the range of approaches taken in the development of CAL packages has resulted in packages with conflicting configuration requirements and disparate operational modes [4]; problems which are emphasised in network implementation. Clearly an initial requirement at Cardiff was to develop a framework for the integration of a diverse range of packages into a unified resource base. To this end a generic

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front-end has been developed from which all CAL packages can be accessed (Fig. 1). This fulfils four primary requirements:

1. It provides a unified interface to modular CAL packages.
2. It enables the dynamic configuration of packages within the Windows environment.
3. It provides centralised monitoring of package usage.
4. It assists in the management of the resource base by centralising individual CAL package specifications.

Initial Results

The implementation work described and the supporting awareness raising initiatives have been developed over approximately 18 months. Results demonstrate the potential benefits of this project, as 14% of the School's lecturers began to use CAL as a result of the material being promoted. An additional 29% indicated that they would like to use CAL if appropriate material were to become available. CAL was used on 12 of the taught courses and approximately 3350 student hours were spent on CAL in one year.

Reactions were elicited from students by a simple questionnaire and were generally very favourable. Figure 2 shows the average reactions of 79 students to a CALGroup module on beam bending theory:

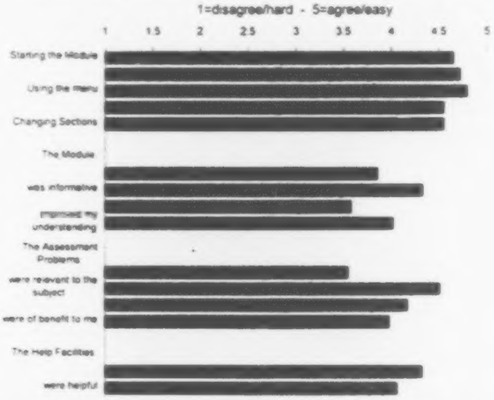

Figure 2: Student Reaction to the CALGroup Beam Bending Module

Whilst these initial results are encouraging it is anticipated that the significant increase in the range of material available for the current academic year and the increased effort being directed towards the promotion of CAL will result in a proportionate increase in uptake both amongst staff and students.

Summary and Recommendations

The Cardiff CAL for Engineering Project is a model based upon the belief that CAL is best implemented by dedicated support staff working closely with teaching practitioners, within specific subject areas. Institutionally, this model could be extended to incorporate several such officers working within carefully selected disciplines; and administered by a central manager. Whilst not the cheapest option, it is likely to succeed in its aims.

The success of CAL as an educational medium clearly relies upon successful implementation. Developers of CAL material should be aware of these implementation issues, to ensure that their software can be implemented with minimum complexity and in a wide variety of infrastructures, with particular reference to:

- Ensuring that CAL software is as stand alone as possible and minimises the need for special configurations.
- Ensuring that modular CAL packages can be used independently and in isolation from any front-end.
- Enabling the local configuration of all file locations and data output paths.
- Providing any user progress and performance monitoring data is a clear and intuitive format.

In the longer term, this paper agrees in principal with the findings of the TLTP EPOC report [4], in the need for software standards for CAL material intended for open provision.

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Using Computers in Teaching Modern Physics

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Abstract. This paper will describe the experience of the joint project, having the same name, developed by two groups one from the Institute for Experimental Physics, University of Kiel-Germany and the second from the Computers in Teaching Initiative Pilot Centre, University of Bucharest-Romania, in the fields of microcomputer based experiments and computer aided teaching / learning in Physics.
A number of *PADI Systems, hardware and software:* were produced: they are able to measure directly and to store in computer a great number of experimental data but also to perform on-line measurements (voltage, time, frequency, resistance, capacitance) and to perform analysis like FFT-Fast Fourier Transform. Non-electrical quantities like pressure, temperature, light, intensity of magnetic filed or induction etc., can also be measured with PADI Systems connected to different sensors, which are able to provide as output an electrical voltage.

Microcomputer Assisted Experiments.

Today it is absolutely necessary for scientists and engineers to use data acquisition and computer analysis in the case of huge amount of experimental data as well as for every day use in their laboratories. For the same reason students should have the chance to learn how to handle the existing products as well as to design and to produce their own according to their needs and financial possibilities.
The main goal of our project was to design and test new solutions for microcomputer assisted measurements as low cost, efficient and elegant alternative to the classical measurements, acquisition, analyze and storage of physical data within the laboratories which can not afford big investments in expensive equipment (schools, universities, some research laboratories).

As a result of the project a number of *PADI Systems* were produced. They are able:

- to measure directly and to store in computer a great number of experimental data but also to perform on-line measurements (voltage, time, frequency, resistance, capacitance) and to perform analysis like FFT-Fast Fourier Transform;
- to measure non-electrical quantities (like pressure, temperature, light, intensity of magnetic filed or induction etc.) using additionally sensors, which are able to provide as output an electrical voltage;
- to perform the remote control of the industrial processes due to the D/A-Out (digital to analog) and D-Out (digital) output channels provided by the PADI interfaces.

The *PC plus the PADI System* is working like an *Oscilloscope with memory* handled by software: the analog experimental data are subject of A/D conversion, then they are fed into the microcomputer, they are displayed/measured or stored on the hard disk for analysis with specialized software (MS-Excel, Microcal Origin etc.). The actual hardware interfaces are connected on the parallel port of a PC IBM-compatible. User friendly software interfaces, GUI type, were prepared in order to run on powerful PCs with Pentium processor and Windows environment as well as on old PCs with 80286 CPU and DOS operating system.

We have designed and tested the following *PADI Systems*:

- 2-channels Oscilloscope working in the range 0÷5 kHz,
- 1-channel Oscilloscope for 1 MHz,
- Multimeter interface,
- 4-channels Timer,
- Steeper motor and Relays interface,
- 1-channel Oscilloscope for 100 MHz (is under way).

Computer Aided Teaching / Learning

One of the most attractive applications of simulation software is in university education because an extremely large range of problems involving very complex system of equations can be easily studied in detail.
The problem is to choose a correct strategy and a good balance between physics and mathematics. A large number of textbooks present numerical algorithms in details and assume the reader to make programming, to write their own lines of codes. The specialists in programming spend years learning the tricks, preparing a good interactive software, maximizing the graphics capabilities and all these things in real-time computation.
That is why we prefer to use advanced software packages which save the students and teaching staff to worry about detailed numerical algorithms and programming and allow them to concentrate on fundamental aspect of Physics. We use in our laboratories powerful tools for simulation and for doing the mathematics necessary for teaching Physics: Derive for Windows, Macsyma and PDEasy which allow the students to perform fast computation, to produce accurate solutions and graphical outputs.

For teaching/learning purpose we are just preparing software packages according to the Romanian curricula but we are also using some of the currently available academic software dedicated to Physics: SToMP package produced by the CTI Physics Centre-University of Surrey UK, PAS-Physics Academic Software, Interactive Physics(IP) and CUPS series. All the time the results of simulation are compared between them and with experimental data, when available.

As it concerns the teaching/learning activities within the Romanian universities and schools, we believe that one computer image has an impact which is stronger that 1000 words and therefore, we have to stimulate the involvement of the teachers and staff in using a good academic software.

Conclusions

- *this paper clearly reveals our willingness to adapt to changing conditions in education field especially to the emergency of the Information Technology;*
- *there is a need to optimize the use of microcomputers in education by improving the access to good and cheap hardware and software;*
- *the computing resources can be maximally exploited not only for informatics field but also for mathematics, physics and other natural sciences*
- *there is a requirement for the decision-makers at institutional level to encourage the use of computers in order to enhance the quality of the teaching/learning process.*

Acknowledgments.

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Computer-Assisted Failure (CAF)

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Abstract: Computers offer great potential to revise the way we approach education. With the digitalisation of information, and the ability to manipulate this information on computers, the way is open for revised models of learning. One such model is "Computer-Assisted Failure" (CAF), since it is precisely through a process of structured "failing" that computers offer students greater learning opportunities. Educators need to re-asses the educational value of "failing" and, using the appropriate hardware and software, incorporate this model of learning into their curricula. This paper looks at the ability of well-designed computer programs to foster creativity, initiative, and critical thinking, arguing that these skills are essential to our modern society.

Breaking the "Success Cycle"

A typical western student's education looks something like this:
Beginning sometimes as early as middle school, students get streamed into those subjects for that which they show most aptitude. Teachers, parents and guidance counsellors offer encouragement to continue in those courses. Positive feedback reinforces an increasingly focused group of skills, while negative feedback, in the form of comments, as well as poor marks, weeds out less proficient skills. As the student moves up the educational ladder, grades become more important. At the same time, the basis on which these grades are judged becomes smaller, sometimes being represented in a 100% final exam. For those who want to move on to higher education, grades become critical in the last few years of high school. The result is a proficient graduate, conscious of his/her abilities, and able to work under pressure. Or, viewed in a different light, the result is a too-specialised graduate, versed in a narrow range of skills, who is poorly trained to take risks.

Traditional structures of education and assessment favour a "cycle of success", a pattern in which students are streamed into areas that they do well in. On the one hand this would appear logical, as well as sensible. Schools, after all, are expected to turn out well-educated and capable young members of society. By focusing on what they do best, schools are merely maximising the potential of each of its students. On the other hand however, such a narrow focus on the part of schools creates graduates untrained and unprepared for failure. Students graduate with an underdeveloped ability to take risk and initiative, and having developed and explored only a limited part of their creative range. Traditional educational values would suggest that there are few instances where a "fail" is regarded positively. The basics of teacher training is to do everything to prevent "failing" in their students. On a practical level, teachers do not have the time to engage in a process of trial and error with every one of their students. Yet in the kind of society we now face, where developments are measured in weeks and months rather than decades and generations, the ability to take risks is crucial. And one does not learn properly to take risks without having learned the essential skill of failing.

Supporting Structured Failure

The use of computers in education is not a new phenomenon. For quite some time now, computers have been used for simple, straight-forward assessment. A right or wrong answer to a mathematical question, for example, is better, more quickly and reliably performed by a computer than by a teacher. The benefit to the teacher, in terms of a reduced assessment load, is obvious. Increasingly, computer programs are becoming capable of assessing more than a simple mathematical, or letter-based answer. However, if the "cycle of success" is to be broken, than computers have to become involved not only in assessment, but in the teaching process itself.

The digitalisation of information, and the ability to manipulate this information on computers has given students unprecedented control over their own learning. In principle, a virtual learning environment can be accessed anywhere, taken anywhere, expanded, created and destroyed at will. Experiments that previously might have had to take place in a laboratory, with limited access and expensive equipment, can be completely simulated on a computer. Furthermore, with a well-designed program, a student can go backwards and forwards in a given experiment, controlling the experiment in a way not possible in the "real" world. Students, freed up from having to worry about using up costly materials, or blowing up the school lab, can work through an assignment multiple times, even improvising or adapting the original task in order to expand or test newly acquired knowledge.

With well-designed software, computers can offer intense one-to-one support, either in the form of a "intelligent computer agent", or in a database which records a student's progress through the program. The latter allows instructors to be "virtually present" during each and every students working process. As many distance-learning projects have discovered, there is great potential in the fact that students and teachers no longer have to occupy the same physical space in order to communicate with each other. For the student, expert assistance need only be an email away. No teacher is an expert on all subjects, and the ability for a student to easily seek out other advice or knowledge can only be seen as a positive advantage to the learning process. Well thought-out and expertly researched software programs, can offer every student the best learning materials and formats available. As computers become increasingly networked, these programs can plug into a limitless number of databases, many offering up to the minute data.

How does all of this create a situation in which the student is not only allowed, but encouraged to fail? The answer is better contextual learning, which is exciting and to which the student can relate. Computer programs can offer students one-to-one structured guidance while still allowing for a great deal of individual freedom and exploration possibilities. Such a structured interactive world can actually train students to take risks. In fact, well-designed programs intend that the user "fail" at some point. By building in incremental levels of difficulty, students rise to the level of their own ability. If the program is well-designed, than students will have to "fail" a few times before pushing on further. I am not talking about the high learning curve which discourages people so much that they end up quitting in despair. I am talking about highly structured, carefully supported, failure. Failure then, changes from being something negative to something positive; a challenge to push on to a higher level of understanding.

While most games offer only a limited, if any, amount of true educational content, for educators there is much to be learned from a gaming paradigm. Game designers know only too well the importance of building in incremental levels of difficulty into a game. There is no reason that this same approach cannot be applied to truly educational content. In essence, good game design requires only that that there is a clear challenge for the user, and that the user is furnished with the necessary tools and information to finish the game. Within that basic structure, there should be exciting things to discover, sudden surprises, and difficulties to overcome. In actuality, the discipline of designing a good game is very similar to the discipline of designing interesting and effective lesson plans. Sound, graphics, and animations do not have to be gratuitous "bells and whistles", but can offer important feedback and information.

Computer-assisted evaluation can also be used to encourage "failure". Software can be designed to record a student's progress through the program, allowing the instructor to evaluate the process rather than the final result. For the teacher, this allows insight into a student's working/thinking, and hence learning, process. Areas of weakness, or misunderstanding can be picked out, sometimes just by seeing where a student became stuck, and what choices were made at given points. The student is given even greater room to fail if the program is structured on a "complete/not complete" model of evaluation. In this model, it is not possible to complete the program, unless a certain level of understanding has been reached. How that level of understanding is reached, or how long, or how many tries it takes is of little or no importance. What is important is that the student comes to understand something new. Failure needs to be considered an integral part of the learning process, and not something to be avoided.

By providing virtual environments in which to explore, one-to-one attention, tracking programs, and the ability for people to manipulate and send data easily, even over long distances, computers can greatly support a model of education which encourages structured failure.

Developing an interactive computer-aided learning suite using a LAN-based Video-on-Demand and a World Wide Web system

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Abstract:

Integrating the emerging video-on-demand (VoD) technology with the Web system and local area network (LAN) which are well established in the Department of Building and Real Estate (DoBRE), the proposed research project aims to develop multimedia, interactive, and self-directed learning units for the subject in Construction Technology. The completed system can deliver more than 40 multiple video streams simultaneously within the host Department's network. Also, a stand-alone version of the completed system can be produced on CD-ROM format to benefit a wide group of users. Once developed and demonstrated the technology can be adapted and applied immediately to other subjects, such as Project Management, and Real Estate Marketing; and later extended to other areas where this type of learning is effective. The successful completion of the project should lead to an improved and innovative way of teaching and learning.

Introduction

This project aims at developing multimedia, interactive and self-directed computer-aided learning units for the subjects in Construction Technology, and Construction Management.

Learning Objects

- have continuous access to video clips showing the different construction processes, methods and techniques,
- observe more "real life" construction processes and techniques than are practically possible by field trips,
- interact with the program, ask and answer questions. Students will be given remedial help from the system if necessary.

Technical Objectives

- produce video recordings of actual construction operations to help students visualise different kinds of construction process, methods, plants and machinery;
- convert the video recordings into digital formats for storage in a computer system for self-directed viewing via a Video server and a World Wide Web server;
- develop a series of complementary course notes for the video recordings in hyper-text and graphical formats via a Web server;
- develop a series of interactive self-review exercises and tutorials via a Web server with a database link;
- exploit the capabilities of the department's well-established networking system (ATM and switched fast Ethernet) and Internet servers (3 Web servers and 2 database servers);
- integrate a LAN-based Video-on-Demand (VoD) system with the Web system in such a way that multiple video signals (streams) can be delivered concurrently to different students via a common graphical user interface, i.e. a Web browser (it is estimated that more than 40 video streams can be delivered simultaneously within the department's network);

Background Information

Typically construction related subjects are taught conventionally in a lecture and tutorial format. Over the years students have expressed their desire to have more opportunities to actually visualize and conceptualize the various construction processes a nd management techniques. The difficulty of teaching these subjects effectively supports this point of view. Whilst site visits, field work and case studies can provide some opportunities for students to visualize these processes, they are far from ideal and are not always feasible due to large class size, tight teaching schedules, inconvenient timing, and location. Video taping the actual construction activities and converting them to digital format so allowing students to view these activities using a series of interactive tutorials via a Web server can provide a better learning facility for the students.

Methodology

The project will draw extensively on both equipment and expertise. However, the Department of BRE is in an advantageous position to develop this system due to its well-established local area network (LAN) which incorporates fast Ethernet switching. This LAN, hence, enables it to enjoy considerable additional benefits by putting in just marginal investment. The process of the project is summarized as follows:

- Subject lecturers will be involved in deciding which areas of the Construction Technology, and Real Estate Management units will require video support and contribute to the development of the subject materials.
- Education technologists will be involved to help design the learning unit. They can also contribute in designing both summative and on-going evaluation of the learning unit. Information technologists will be responsible for setting up the VoD server, developing algorithms for the interactive and multimedia contents on the Web server. Media specialists will help edit and convert the video contents into digital formats.

Evaluating the success of the project

The project can be evaluated by 4 means. Firstly, direct feedback through face-to-face discussion with the students will be conducted regularly to ensure that the developed system actually meets the needs of the end users. Secondly, a user-oriented questionnaire will be designed in consultation with education technologists (our input from the Education Development Unit) to solicit opinions from the end users. Questionnaires can be distributed both electronically through the Web server or manually to the students undertaking the learning units. The aim is to ensure that adequate and representative samples can be obtained from the population. Thirdly, a log of Web hits can be recorded and random statistics inspected to reflect the frequency of utilization and the popularity of the system. Lastly, the development process, lessons learned, and the effectiveness of the developed units will be documented and published in international journals of higher education teaching to facilitate a world-wide forum on the project. It is expected that a proper peer-group assessment as adopted by most refereed journals can provide a fair and reliable evaluation to the success of the project.

Conclusion

The department of Building and Real Estate has been investing fairly heavily in constructing a robust and scaleable infrastructure for information technology and is looking forward to enjoying the benefits. Although the context of this project is in construction, we found it totally feasible to adapt the technology in any other subject areas. We are developing applications for real estate marketing and management with decision making processes and simulated role-play sessions built-into the learning units. If it could be delivered by cabled TV system, its contribution to distance and open learning will be even more enormous.

Problem Solving in a Multimedia Environment

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Abstract: Computer systems are increasingly useful tools in the teaching and learning process. Teachers can utilize software to expand upon an idea, to provide practice, and/or to give students limited access to an experience which would be otherwise unobtainable. This study looks at how the multimedia program *Myst* can provide learners with an opportunity to obtain and utilize information so that problem solving can occur in a rich, simulated, environment. This kind of environment is becoming increasingly important in education as teachers attempt to implement active learning projects under the influence of constructivist and situated cognition ideas.

Introduction/Theoretical Frameworks

Problem solving research is a highly developed and important area of research in psychology and education. Critical thinking and problem solving skills are prominent national educational goals. Currently, most problem solving research has dealt with either experimenter presented problems which are simple and easily repeatable [Newell & Simon 1972] or real life situations which are complex and unique [Lave & Wenger 1991]. This study used the popular multimedia game *Myst* [Broderbund 1994] to provide a complex, yet fully specified, problem solving environment. The total group of situations was constant, because the CD-ROM is fixed, but each user experienced a different subsegment of situations at any given time. This study was guided by the general expectation that a detailed examination of the subjects' exploration of the *Myst* world would reveal both common strategies and consistent differences in their approaches to learning and problem solving. Understanding both the similarities and differences is important for guiding the development and use of multimedia for education.

The study discussed here has many theoretical homes. Methodologically, this study was a qualitative case study with roots in the process-tracing approach pioneered by Newell and Simon [Newell & Simon 1972]. The theoretical background for this study is grounded in cognitive psychology, constructivism, and situated learning. Additionally, recent problem solving research was extremely influential during the data analysis, especially the literature on experts. The two informants were both skilled problem solvers in non-*Myst* domains. The informants progression from novice to non-novice *Myst* problem solvers was the focus of data analysis. Expert and novice problem solving has been extensively studied [Chi et al. 1988]. General conclusions indicate that increased domain-specific knowledge, organization of this domain-specific knowledge, and the identification of problem constraints are the main parameters that separate experts and novices in problem solving.

Research Methods

This research used the *talk-aloud* method for research [Ericsson & Simon 1993]. Very detailed observations were recorded of a small number of subjects as they played *Myst*. The resulting protocol was then analyzed extensively. *Myst* is a very popular commercial computer game with a reputation for breaking new ground in interactive multimedia technique. When the program begins, the player is transported to a small island with several buildings and mysterious items. The player clicks with the mouse to manipulate the objects that appear on the screen and to move from one view of the island to the next. Playing the game consists of figuring out what all the items do and how to use them. Two university-aged informants, one male and one female, volunteered to serve as informants. Both informants could be considered experienced problem solvers in non-*Myst* settings.

The informants played *Myst* in the researcher's home computer room for six sessions each. A VCR recorded all the players' movements while using *Myst*; the computer screen output was the video input and the informants' *talk-aloud* comments were the audio input. The informants attempted to say aloud the answers to the following questions: What did you just do? What did you find? What do you think about it? Why did you do what you did? The general idea was to identify the mental processes used by the informants to solve problems within the game's environment. The researcher was present during all sessions to prompt the informants to continue to talk aloud and to take field observations. Informal debriefing interviews occurred during the sessions and at the conclusion of the study. The most rich data was related to the problem solving procedures used by the informants to progress through the program. Initial analysis related to *Myst* locations. The second layer described what was happening at the time (strategies, feelings, etc.). The final layer related to novice and expert problem solving skills.

Results/Conclusion

Both informants progressed from novice to skilled *Myst* problem solvers during the study. More importantly the two informants enjoyed the experience and this enjoyment kept them coming back to use *Myst*. This enthusiasm enhanced their problem solving learning experience. Both players solved one of the key problems and got the space ship working. Being able to identify problem constraints is challenging, especially in *Myst*, but it is essential to problem solving. Problem constraints included the key *Myst* locations needed to start the space ship. Both players used many novice and expert problem solving strategies.

As the learners used the multimedia game, they greatly increased their domain-specific knowledge. When activating the space ship, both informants learned how to move through the island, discovered what the marker switches did (activated a light on the map hanging in the library) and learned how to acquire needed knowledge in the library. The importance of domain-specific knowledge was seen in the difference between the two informants approach to powering up the ship. The second informant, with previous electrical experience, demonstrated expert behaviors when he moved efficiently between the generator control room and the circuit breaker towers to get power to the space ship. Once he verified that both gauges had actually worked at the beginning and saw the circuit breaker towers, he efficiently got the space ship powered.

Data organization was an evolving process. During the first session, both informants just wandered around the island. Every detail was separate. After a couple sessions, information was beginning to be chunked and grouped together as either "potentially important" or "just nice to have." Another interesting example of the increased organization of knowledge is related to the informants' journals. During the final interview, the first informant mentioned that she would take higher quality notes if she ever played a sequel to *Myst*. She felt that she would now know what was or was not important.

Experts move from the problem to the solution. This behavior decreases the probability that they will get frustrated and stop working toward the solution. Another related idea is that experts are more likely to set, and meet, subgoals which move them closer to the ultimate solution. Subgoals were set by both players and they usually stopped the current session when they were met. For example, both players stopped the session when the space ship door opened. Within an hour of the beginning of the next session, they had the space ship running.

Informants were clearly developing skills as problem solvers in the *Myst* environment. A study like this provides little demonstration of generalization, but the informants volunteered changes to their own problem solving style and skills. Specifically, they mentioned that note taking is a good way to remember important information and indicated that the next time they played *Myst*, or were in a similar situation, they would take more notes from the start. Additionally, details became more important. They learned to distinguish between "important" details and "decorative" details. A final conclusion was that the informants may have learned the value of the systematic elimination of options when problem solving. Random guessing was unproductive; it lead to frustration. When armed with even a minimal clue, the process of solving a problem was much more enjoyable and efficient. The prospects for generalization of problem solving skills obtained in the *Myst* environment should be enhanced if the game is played in an educational context. The teacher can help the students make connections between strategies learned and their application in other situations.

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Integrated Educational Environment for Designing of LSI

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1 Introduction

Research for use of the Web as a teaching platform has been done. [1] [2]The advantage of Web is that client computer independent of kinds of computer. In the Japanese technical college, after students learn the theory and they becomes parts of their technology via experiment after students learn the theory in the lesson. But by means of students laboratory work require much equipment, time and cost nowadays laboratory works are generally done on computers. Computer simulation is a valid method to verify behavior of system, to check truth of design and so on. We have some commercial computer simulation software so called CAD. But we have to spend much time to learn how to operate them well. Because they are not educational tools.

CAI systems using CAD have been reported by Kurose [3], Matsunaga[4]. Kurose has reported a CAI system for learning free curve and free curved surface. The issue of this system is that learning topics are limited, equations and program of free curve and free curved surface are given then students can not make any computer programs to check behavior of different equations and students deal with different equations on this CAI system. In short students does not independently learn the 3D curve or surface. Matsunaga's report focused the student model. Furthermore his system doesn't support Network and has only character base user interface.

Engineering education in higher education have to offer the students integrated educational environment which combines hyper text book, simulation software tool and high flexibility.

In this paper we describe a design and implementation of integrated LSI design educational system. Furthermore we discuss the learning environment which focus designing in technology education.

2 System Configuration

2.1 Specification of System

Designing of LSI is generally carried out by Fig.1 shown procedure. This system needs as follows functions.

1. dealing with files which are created by learners
2. Editing and Compile
3. Simulation for checking program
4. Output circuit diagram and Synthesis logic circuit
5. Net list for burning FPGA(Field Programmabl Gate Array, Consumer can customize IC)
6. Hyper text book
7. Online manual and help
8. Linkage others Web Site
9. Direct manipulation user interface

One of authors will apply this system to his class. The contents of hyper text book is combinational logical circuits, sequential logical circuits and small educationa computer.

2.2 Configuration of system

We have various software tools to design LSI, free software or commercial software. We adopted PARTHENO made in NTT Japan because as PARTHENON works o UNIX, server client system easily is built. In the system PARTHENON works behind Web Server on UNIX Learners access the PARTHENON via Web browser an cgi. Users files accounting is carried out user id and password. Fig.2 shows system configuration.

Handling files, create, remove, list and so on is carrie out by executing cgi program which issues UNIX command with clicking buttons of Web browser. User ca edit program on input window of Web browser. Som parameters needed in simulation are transferred via cgi Output of circuits diagram comes up browser from converting ps file format to Web browser format. Cgi programs are created with UNIX shell scripts and Perl programs.

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2.3 User interface

Learning environment offers GUI on Web browser to users. User can edit a HDL program in window of browser, editing means removing, appending or copying character strings. File accounting, New file, Open file, SaveAs etc are carried out by choosing a menu from pull down menu. Programs by HDL can be compiled by clicking button and analyzing error message routine point out the correspond statement. Time chart comes up windows in simulation, of course we set initial values of each register, flip flop and various variables. PARTHENON has been developed in NTT Japan. We can get much information about PARTHENON from NTT Web site. Furthermore a few universities have Web sites for teaching material using PARTHENON. Then this system has link page for the Web sites. Designing of LSI should be realized as a hardware. Then this system has link page to producers of FPGA in order to obtain much information of FPGA. Because system should navigate user valuable Web sites.

3 Conclusion

We have described architecture of IESDL(Integrated Environment Designing of LSI) as a CAI system. We can say that technology education field demands like this integrated learning environment because this system offers hyper learning environment to users. In short this system does not simply combine text book, reference, software tool but they are integrated. In next academic year we will apply this system to class in order to evaluate and improve the system.

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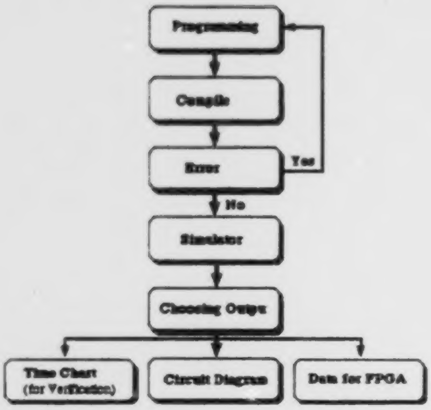
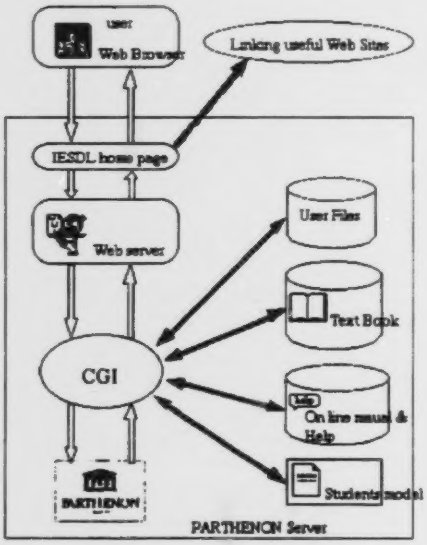


Programming
Compile
Error
Yes
No
Simulator
Choosing Output
Time Chart (for Verification)
Circuit Diagram
Data for FPGA

Figure 1: Flow of LSI designing with HDL Tool



user
Web Browser
Linking useful Web Sites
IESDL home page
Web server
User Files
Text Book
CGI
On line manual & Help
Students model
PARTHENON
PARTHENON Server

Fig.2 Architecture of IESDL
(IESDL: Integrated Educational Environment for Designing of LSI)

Pronunciation Power: A Hypermedia Pronunciation Program For Learners Of English As A Second Language

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Abstract: In order to improve communicative competence, second language learners need to develop intelligible pronunciation. This paper describes a multimedia computer program designed to teach pronunciation to students of English As A Second Language. The program includes video of native speakers pronouncing individual sounds, words and sentences. The learner is then able to imitate the mouth position as well as the sound of the speaker. The program provides opportunity for practice and includes material designed to keep the learner interested while studying.

Introduction

Students of English As A Second Language (ESL) are often highly motivated to improve their listening and speaking skills in order to communicate effectively. However, poor pronunciation skills, especially in the case of adult language learners, hinder their ability to communicate. A large number of teaching materials have been developed to improve the listening and pronunciation skills of ESL students. These materials have changed with the progress of media such as cassette tapes, video tapes, CDs, laser disks and computers.

ESL students cannot expect to greatly improve their pronunciation simply by spending a few hours a week in a pronunciation or oral skills class. Materials are needed that allow students to work individually on their pronunciation skills in a language lab. These materials can be used on their own or as a supplement to a class.

In order to help ESL students improve their pronunciation skills, one must consider three factors – imitation, repetition, and interest. First, imitation is essential in acquiring intelligible pronunciation. Each sound in the English language has a specific articulation involving movement of various parts of the mouth. Students learn to pronounce sounds accurately when they are able to model placement and movement of the lips, tongue etc. Next, repetition is essential. Students may be taught to correctly position their mouth to produce a target sound; however, only through practice can students learn to produce that sound as part of words and sentences. Finally, materials must be interesting and varied. If the materials are boring, the students might not use them.

With this in mind, we will now discuss different media of language instruction. First, cassette tapes are very convenient for learners. Because they are inexpensive and easy to carry, they are widely used. However, though cassettes allow students to hear correct pronunciation, they do not show the movement of lips and tongue. Moreover, it is difficult for students to repeat parts of the tape should they need more practice on a certain section. Second, CDs are similar to cassettes except that it is easier to repeat sections on a CD. Next, the video cassette is superior to the cassette tape in that students can see the movement of the mouth. However, it is also troublesome to repeat sections and is inferior to the cassette and CD in portability. The laser disk is currently an excellent medium for studying and teaching English pronunciation as it enables students to access and repeat any parts that they wish. In addition they can see and imitate the native speaker's lip movements. As we can control laser disks with a computer easily, we are able to design interactive teaching materials for this medium. However, because laser disks are less popular than other equipment, not many students have access to them. Finally we would like to focus on the computer. Recently the price of personal computers has gone down and the performance has risen considerably. Most personal computers have CD-ROM capability with speed more than four times that of a music CD and which can play MPEG and Windows AVI files smoothly. Moreover, as we can buy a CD-ROM writer for less than $800, we can make teaching materials easily with multimedia.

Description

Pronunciation Power has four main chapters – vowels, consonants, stress and rhythm, and intonation -- which each contain several lessons. Each lesson has three main sections – an explanation of the target pronunciation point, a model performance with opportunity to practice, and a quiz. First, in the explanation, a teacher explains and demonstrates how students should shape their lips and where they should place their tongue in order to make the target sounds. Students can listen to the explanation as often as they wish. Second, in the model performance and practice section, the teacher pronounces at least ten words and sentences. The learners see a movie of the teacher pronouncing the words and sentences and imitate the teacher. Students can select words that they wish to hear and say again. The individual learners have the opportunity to focus on the words that are most difficult for them. Finally, in the quiz section, students cannot see the movie of the teacher; they only hear the quiz sentences. Take the "th" sound for example: The computer has a list of words containing the "th" sound and similar words containing the "s" sound. Ten words are selected at random. The students then hear a native speaker say a sentence containing the quiz word. They must decide if the word they heard was a "th" word or a "s" word. Because the sentences are chosen at random, the student cannot memorize the correct answers – they will be different each time. The computer points out the words that the learners missed and they can practice those words again.

We are developing a fourth section for each lesson – model dialogues. Students will hear a dialogue between two people using words containing target sounds. They can listen to and repeat the sentences and target words in the dialogue. We hope that this section will help learners integrate target pronunciation into their speech outside class.

We plan to add some other functions to our program. Students will speak into microphones and the computer will judge the accuracy of their pronunciation. We also plan to record students' learning histories and analyze the characteristics of individual students and of all students.

Pronunciation Power addresses the three considerations mentioned earlier in this paper – imitation, repetition, and interest. When using this program, students see a movie of the teacher and other native speakers. Therefore the learners can imitate mouth position as well as the sound of a native speaker. Pronunciation Power gives ample opportunity for repetition and practice. Individual students can specifically focus on areas in which they need work. This program will enable students to develop not only their pronunciation ability but also their listening comprehension. Listening to a variety of native speakers with the option of replaying each passage will help the learners improve their listening skills. The quiz sections (which generate new quizzes each time they are replayed) and the dialogue sections make learning fun and ensure that students will go back to the program again and again.

Though our Pronunciation Power project is not yet finished, we believe that the current version is also beneficial for ESL students. In order to demonstrate this, we plan to test Pronunciation Power in ESL classes. Student and teacher surveys will allow us to make positive changes in our project in order that Pronunciation Power develops into a useful and interesting tool for language learners.

The Effects of a Spatial Map and a Conceptual Map on Navigation and Learning in Hypertext

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Abstract: This study shows a dissociation between navigation and learning in hypertext as a function of navigation/learning aid. Subjects used either a spatial map or a conceptual map and were asked to read a hypertext document, after which measures of navigation and learning were taken. The results showed that navigation was best with a spatial map while learning was best with a conceptual map. Subjects with no aid also navigated poorly, but their learning was better than that of the spatial map subjects.

Introduction

Spatial maps are often used as navigational aids in hypertext. However, research has shown that while spatial maps can facilitate navigation (McDonald and Stevenson, 1996) they do not facilitate learning (Wenger and Payne, 1994). One possible reason for this, is that spatial maps only depict the structural layout of the document. That is, they only show which nodes are related, they say nothing about the nature of the relationship, or why it exists. Thus, although such aids may assist users in their search for information they are unlikely to facilitate conceptual understanding, and it is conceptual understanding that underlies effective learning. What seems to be needed, therefore, is an aid that facilitates conceptual understanding of the text. We therefore constructed such an aid, which we called a conceptual map. In contrast to a spatial map, a conceptual map identifies the key concepts in the text and specifies the relations between them. Our study, examined the effects of a spatial map and a conceptual map on navigation and learning in hypertext. Subjects were instructed to read the hypertext document. They then searched for ten target nodes, the time it took to locate each node and the number of additional nodes opened over and above the minimum necessary to locate each target node was recorded. Subjects then answered forty questions about the text. Half of the questions tapped memory for factual information the remaining questions required a deeper understanding of the text. One week later subjects competed a retention test.

Results

For the navigation measures, statistical analysis showed that performance was best with the spatial map, next best with the conceptual map, and worst with a pure hypertext. The above order held for both the time it took to locate the ten target nodes and the accuracy of the subjects' chosen route through the document.

As regards learning, statistical analysis showed that for the factual questions, performance was better at acquisition than at retention. In addition, overall performance was comparable with the conceptual map and the spatial map which both produced better performance than a pure hypertext. However, navigation/learning aid interacted with time of testing. At acquisition, spatial map and conceptual map subjects performed comparably and were both better than hypertext only subjects. At retention, conceptual map subjects performed better than both spatial map and hypertext only subjects, who performed equally well. This interaction occurred as a result of the poor retention of the spatial map subjects. For the main ideas questions, performance was better at acquisition than at retention, performance was best with the conceptual map, next best with basic hypertext, and worst with the spatial map. There was also an interaction between test phase and aid, which occurred as a result of the poor retention of spatial map subjects, who demonstrated quite dramatic forgetting across the two test phases.

Discussion

The results showed that navigation was best with a spatial map while learning was best with a conceptual map. Subjects with no aid also navigated poorly, but their learning was better than that of the spatial map subjects. The spatial map and hypertext only results for navigation are consistent with previous findings (e.g. McDonald and Stevenson, 1996). The observation that a conceptual map also facilitates navigation relative to basic hypertext is most likely due to the fact that spatial information and conceptual information overlap.

As regards the learning of facts the results show that a spatial map and a conceptual map produced comparable learning immediately after acquisition, but after a week's delay, spatial map subjects showed poor retention compared to conceptual map subjects. These results support the idea that a spatial map helps subjects construct a superficial structural representation of the text that is useful for retrieving factual information but that decays very quickly. With the main ideas questions, the conceptual map subjects outperformed the spatial map subjects at both retention intervals. This result also supports the idea that a spatial map leads to the construction of a superficial representation of the text. It also supports the idea that a conceptual map facilitates the construction of a mental model (Johnson-Laird, 1983) of the information in the text. A situation model encodes the relationships between concepts, including concepts already stored in the learner's long term knowledge store, and such an integrated representation supports the long term retention of facts and ideas.

The performance of subjects in the hypertext only condition on the factual questions was poorer than with either aid on immediate testing, and poorer than with the conceptual map after a delay. With main ideas questions, performance at both test phases was better than with a spatial map but poorer than with a conceptual map. These results suggest that pure discovery learning with hypertext favours conceptual understanding at the expense of the acquisition of new facts, although even conceptual learning is not as good as with a conceptual map. This suggestion is consistent with the idea that pure discovery learning in hypertext is time-consuming, and further indicates that facts are more likely to suffer than ideas.

In summary, these results favour the use of a spatial map in navigation and information retrieval tasks, and a conceptual map in learning tasks. Basic hypertext also encourages learning, but the time spent navigating through the document may delay its beneficial effects, particularly when learning facts, and this may deter all but the most highly motivated learner. By contrast, the constraints imposed on navigation by a conceptual map not only reduce the time spent exploring the document but also significantly enhance learning.

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Evaluation of a Multimedia Program Designed to Engage Students in Scientific Inquiry

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Abstract: Multimedia software that is intended to support science education reform must be designed so that teachers can successfully adapt it to their local circumstances. This short paper describes efforts at the NASA Classroom of the Future to develop techniques for evaluating the extent to which teachers can successfully adapt its multimedia software.

Introduction

Over the last century, science educators have tried repeatedly to reform science education. From decade to decade the goal has been the same: to help students engage in scientific inquiry and cease being passive receptors of information. In every era of reform, there have been pilot projects that have successfully engaged students in scientific inquiry. In those pilot projects, students learned more and developed healthier attitudes toward science than did students in traditional science classrooms [Shymansky, Kyle, & Alport, 1983]. However, those projects have not become the norm in spite of their promise. Actual classroom practice has remained intractable. Researchers have observed that despite outward appearances, what actually goes on in today's science classrooms remains strikingly similar to the rote practices of the nineteenth century [Bybee & DeBoer, 1994]. Why has it been difficult to extend science education reform beyond the successes of a handful of pilot projects?

According to Cuban [1993], reform efforts often fail to sustain at the classroom level because they largely ignore the inevitable fact that the reformed curricula provided to teachers must be adapted. In their efforts to accommodate the often conflicting demands of many constituencies such as school boards, administrators, parents, and students, teachers cannot use all instructional techniques and materials exactly as intended. Real-world constraints necessarily factor into how teachers implement reform in their classrooms. Teachers are forced to become instructional designers, making decisions about what features of the reform to adapt and what features to preserve. However, if teachers make the wrong adaptations, if they overlook or distort the critical elements of the innovation, not only will students fail to engage in scientific inquiry, but the entire reform movement itself will be judged by the failed implementations. Therefore, it is essential for multimedia designers to investigate how teachers can successfully adapt the software for use in their classrooms.

This paper reports on preliminary results from a pilot evaluation of the *Astronomy Village* multimedia program developed at the NASA Classroom of the Future (COTF) program. *Astronomy Village* presents a virtual mountain-top observatory interface from which students investigate contemporary problems in astronomy [see Pompea & Blurton, 1995 for a description]. After selecting one of ten investigation pathways, students are guided by talking, virtual mentors through the steps of scientific research: background research, data collection, data analysis, data interpretation and presentation of results. The software is intended to help teachers support students at engaging in scientific inquiry. The goal of the evaluation efforts being conducted by the author is to understand the variety of ways that classroom teachers can adapt *Astronomy Village* to engage students in scientific inquiry. For his research on *Astronomy Village*, the author has adopted "academic tasks" as a theoretical perspective for investigating the intersection between teaching and learning [Doyle 1983]. An academic task is defined by the goals that students are expected to accomplish, the resources that are available to students while they are pursuing the task goals, and the operations that students can use in manipulating the resources to accomplish the task goals. Teachers will be able to successfully adapt *Astronomy Village* if they can design academic tasks in which students use the software as a task resource to achieve the task goal while employing operations that mirror scientific inquiry. In order to investigate the ways in which teachers can adapt *Astronomy Village*, it is necessary to develop techniques for determining the extent to which students achieve a task goal and the extent to which the students' task operations reflect scientific inquiry.

Evaluation

Thirteen students from the freshman class of a local girls academy served as the pilot study population. The students came to the COTF test facility in lieu of their science class every day during a four-week period (April-May, 1996). The unit that involved the use of the *Astronomy Village* was co-taught by the author and the students' classroom teacher. The academic task goal that the teachers defined for this evaluation was that students conduct each and every activity that the virtual mentor suggested for each of the phases of scientific research. As part of that task goal, students developed an activity summary for each activity in the LogBook provided by the software. The activity summary consisted of a brief description of the activity, a statement of how the activity related to the main research question, and any new questions that arose from the activity. Thus, the activity summaries served as a record of what students were able to accomplish.

Conclusions

The overall evaluation will investigate both students' ability to accomplish the *Astronomy Village* academic task goals and the extent to which the operations that students used mirrored the process of scientific inquiry. However, the data analysis for this short paper focuses on techniques for measuring the extent to which students accomplished the academic task goals. The number of activity summaries that students developed was divided by the number of activities that the mentor suggested in order to determine the task completion rate. The task completion rate can be used as a measurement technique for determining how closely students achieve an academic task goal. The average task completion rate for this study was 42%. This value indicates that over the four-week period, students completed less than half of the activities that the mentor suggested. An analysis of the task completion rate within each phase of research (i.e., background research - 55%, data collection - 75%, data analysis - 35%, data interpretation - 20%, and presentation - 27%) revealed that the task completion rate was much lower during later phases of research. Based on the poor performance of the students, the *Astronomy Village* academic task structure is being modified to improve students' ability to accomplish the task goal. For example, students should be given deadlines for each phase of research so that they will have sufficient time to complete later phases of research. The task completion rate is only one technique that can be used to evaluate the ways in which the software and/or task goals need to be modified. Subsequent analyses will help identify techniques for measuring the extent to which the task operations mirror the process of scientific inquiry.

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A TCP/IP Daemon that allows Inter-Application Communication across the Internet

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Abstract: This paper describes the specification and architecture of a remote teaching system developed in the COPERNICUS Project "Learning and Educational Access using Remote Networks - Enabling the Disabled" (LEARN-ED). It briefly characterises a major part of this system - universal inter-application network communication facility - that is currently used as a vehicle for controlling the presentation of the lecture slides on remote students' machines and locally. Our system is available for all the popular platforms (MS Windows, MacOS, UNIX) as well as for a special one (KA9Q).

1 Introduction

Development of a suitable method for remote teaching was a key task in the LEARN-ED project aimed at finding ways of improving the access to University or Higher Education studies for students with disabilities. Nevertheless our method can be employed by able bodied people as well, because its usability by handicapped persons is mostly the matter of terminal adaptations. The project itself dealt with the problem how telecommunications technology can be used to enable teaching activities and information to be available to students, even when the students are not physically at the site of the teaching activity and information. To support remote education the consortium dealt with both access to persistent information and access to live activities. This paper is focused on the second type of activities.

2 Functional Specification

The requirements involve relaying events to another location on campus, using the campus LAN, but also to an off-campus location, using ISDN, PSTN, or radio links. The core events of interest are the teaching events, when common information being presented or discussed should be available to the remote student. In addition, the student should be able to participate in the discussion by receiving and presenting audio, live text chat, and, if possible, video. The principle functional components of the required service are:

- Audio conferencing between each remote student and the participants in the same venue as the event
- Video conferencing between each remote student and the participants in the same venue as the event
- Text conference abilities to allow specific detailed data to be exchanged (e.g. e-mail or URL addresses)
- Whiteboard facilities to allow all participants to view and annotate commonly visible documents
- Teaching material display to all local and remote participants (the timing and sequence of material to be displayed should be under the control of the director of the teaching event, e.g. the lecturer or the tutorial leader).

3 Technical Specification

The LEARN-ED remote teaching system functions within an Internet Protocol (IP) transport infrastructure, the most prevalent infrastructure technology at universities. The services are intended to be accessed by individual students using desktop personal computers or workstations. The hardware requirements are relatively low to keep the costs of the equipment to realistic levels. All commonly used platforms (MS Windows, MacOS, UNIX) are supported.

3.1 Conferencing Service

The functional requirements for video, audio, and text chatting facilities will need to be provided over low bandwidth links. Some systems have been developed to provide these functions across TCP/IP Internet links. This is attractive because the same network technologies could be used for the information and the conferencing services. The *CU-SeeMe* videoconferencing system is available for both Windows and Macintosh environments. On UNIX systems the *vat* audio conferencing and the *nv* video conferencing system can be used.

3.2 Information Distribution Service

One of the basic requirements for this remote teaching system is the ability to display the teaching material to both local and remote participants. We have chosen presentation of the teaching material in the form of HTML pages, mainly because of platform-independence, widespread acceptance, and good network bandwidth utilisation in comparison with the "traditional" method of sending the material as a video image.

Netscape Navigator has been chosen to display the teaching material as it is possible to manage this browser using its Application Programming Interface (API); via OLE or DDE under MS Windows, via AppleEvents mechanism under MacOS, and via X Window System facilities under UNIX. We have developed a system for generating and relaying such API messages over the TCP/IP network, so the lecturer can instruct the students' Netscapes to display the chosen slide.

3.2.1 Inter-Application Communication Facility Architecture

At last we shortly describe the architecture of this facility. As stated above, the system allows the platform specific API message to be relayed over a TCP/IP communication infrastructure. Basically there are these three types of components within the system:

- Controllers
- Daemons
- Controlled applications

A *controller* generates (on behalf of the user) API messages for the controlled applications. It sends them to the *daemon* running on the same machine as the controller. The daemon relays them to the daemons on the remote machines. Each of them relays the message to the appropriate application (*controlled application*). The success or failure is reported (via daemons) to the controller.

Messages sent from the controller and relayed by the daemon are platform-specific messages (DDE, AppleEvent messages and shell commands for the MS Windows, MacOS and UNIX platforms, respectively) encoded as text. The links between daemons are TCP links. The format of the messages is uniform, so daemons for all supported platforms are interoperable. As a rule, each machine runs one daemon. It is possible to run more controllers together with more controlled applications on the same machine.

Conceptually, the daemon is a simple component. It just relays messages and does not translate them between formats required for each platform. It is the responsibility of individual controllers to know which operating system is running on each remote host and to send suitable messages. Each remote machine informs the controller of its type when a connection is established. This strategy supports flexibility of the system as the daemons are universal and need not be modified when new controllers and applications are employed.

Acknowledgements

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Helping Teachers to Produce Effective Computer Assisted Learning Material

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Abstract: We have developed a software package to promote a resource based approach to learning whereby individual subject areas are not considered as the topic of a single "closed book" approach to CAL but are studied by electronically collating via hypertext, as many relevant resource files as are available to the developer. These would include text, pictures, help files, video, sound and animation. It is exploitation of these resources and their constant updating which should make CAL unique as a teaching medium.

In the United Kingdom, the desire to increase the amount of technology based teaching in higher education has been reflected in the large amount of Government funding dispensed through projects such as the Information Technology Training Initiative (ITTI) and the Teaching and Learning Technology Programme (TLTP). While these initiatives have had some success in producing quality material, the teacher with an interest in producing CAL faces several obstacles. One is that the authoring tools available today, require extensive commitment of the teacher's time and usually skilled support (programming skills, educational technologists, graphic designers etc.) to produce quality material (see Laurillard, 1993)

The second problem arises when the first is overcome, and that is that many of the packages represent a "closed box" approach to the presentation of information, ignoring the needs of the host teacher to include their own knowledge and teaching material within the CAL package. The production of these packages has been patterned on the publishing of a book. Teaching methods have traditionally used books and lectures as the cornerstones of information transfer. With the introduction of CAL material and its interactive delivery mechanism, the production of "closed box" material is failing to capitalise on its interactivity and its ability to present the very latest information at the click of a button. Without some means of adding their own input to such a form of learning it is hardly surprising that a beginner in CAL or a sceptical academic may feel:

a) The material is "not quite right" for their course.
b) Distanced from the learning process.
c) That the package will rapidly become obsolete unless upgraded by its authors.

In summary, such CAL packages look beautiful, but are ring fenced by the fact that they cannot be changed or updated, annotated or integrated into a teaching strategy. As a book, it may well be recommended by the local staff, because even if it was considered weak in certain areas those areas would be addressed by local staff via their own teaching methods. The equivalent task with CAL would be to add new software content, and while a subject expert may be eager to update their work (the "second edition" analogy in the context of book publishing) the team of people involved with the project may be otherwise engaged or at worse disbanded.

There is a thus a need to develop a method by which teachers with basic computer skills can collate those information resources best suited to CAL into a single package which can be easily extended and updated. Chief amongst this material would be text and pictures but the former can be improved via a hypertext structure whilst the latter can be "active" pictures which lead to further information. Those resources best suited to CAL would of course be video, sound and animation. It is these resources and their exploitation in interactive teaching which should make CAL unique as a teaching medium. Such a process has been begun by the very elegant "Microcosm" software developed in the UK by Hall et al (1). However such software is expensive and still demands significant computer skills to be used successfully.

We have developed a Windows based program which functions by providing a simple text based outline of the topic under discussion with the possibility of including multiple hypertext links to the resource material. Thus a single word or phrase activates the material (for example a video file) or alternatively presents a menu of ALL the resources relevant to that particular topic e.g. graphics, new text, video clips etc. Such resources are loaded via their parent application e.g. a resource which is a spreadsheet file loads the parent program which then displays the spreadsheet. Such an approach extends the teaching methods a teacher might already use (for example with printed versions of a spreadsheet) by allowing the student to interact with the material. Any such modifications could be saved locally by the student as their own additional material but assuming the original teaching material was delivered over a network, the appropriate access authority would prevent the original material being altered. This approach demands only that the developer know their list of resources and can link them to words or phrases, and enables the regular addition of new resources into the package. These resources could be complete software packages (e.g. the user loads a simulator) or simply resources such as additional text documents, spreadsheets, new web sites etc. This should help to remove the obsolescence factor built into a closed box package. In addition, the selection of quality student essays by the teacher for subsequent use as a resource should encourage new students to contribute to their own learning by developing/extending such material. It will encourage staff with little or no authoring skills to assemble basic resource packs which students can personalise, extend and own.

As an example of the use of our program our medical students were invited to produce three CAL packages as part of a Special Study Module on "Designing CAL". Ten students worked in three sub-groups to produce resource packs covering Microbiology, Hypocalcaemia and the Epidemiology of Infectious Disease. They had access to subject experts and were supervised by experienced CAL designers. Within two weeks they produced a "resource pack" which collated:

a) Pictures scanned from staff slides.
b) X-rays scans (as bitmaps)
c) Text from the WWW
d) Text produced in house from lecture notes etc.
e) Assessment questions produced by our own software program
f) "Powerpoint" presentations.
g) Windows help files constructed in house from material supplied by the students.
h) Video files

These materials are now being edited and will be integrated within the existing CAL material used within the Medical School. It is our experience through workshops and projects such as that described above that teachers who are interested in CAL but unwilling to master a complex authoring package can produce useful material which exploits the inherent strengths of computer assisted learning.

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Developing a Laurillardian CAL Design Method

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Abstract: This paper discusses design methods for CAL and proposes that existing methods are based on out-of-date educational models. The paper suggests a more suitable educational - Laurillard's Conversational Framework - and describes how this was used to help develop a new CAL design method.

At MediaActive '94, Professor Alistair MacFarlane delivered his keynote address entitled "Future Patterns of Teaching and Learning." He stated:

> *"Learning is an interactive and dynamic process, in which imagination drives action in exploring and interacting with an environment"*

Later in the article he stated:

> *"As we move into the next century, technology thus provides us with both a challenge and an opportunity. The challenge is to find out how to construct and deploy highly supportive environments."*

The key phrase being "construct." So how have we traditionally constructed or designed these educational multimedia environments? If any design method is employed, it has been a top down decomposition approach, like early software engineering methods; overall educational aims are identified for the learning package and from these, learning objectives are derived. These objectives are further subdivided until each objective can be directly implemented by a single teaching instruction. This approach implies that teaching causes learning directly, that each piece of the package can achieve one of the learning objectives. This paper suggests that the underlying model of the teaching and learning process in these design methods is not appropriate for higher education and proposes Laurillard's conversational framework as a more suitable model.

Laurillard's conversational framework [Laurillard 1993] takes a different approach to the teaching and learning process; the framework identifies twelve activities that should be performed by the teacher and student for each learning objective. The activities are described as *mathemagenic* activities i.e. activities likely to promote learning. This approach acknowledges that learning is not reliably caused by any single type of teaching event. These activities fall into four categories; Discursive, Adaptive, Interactive and Reflective. The fundamental idea behind the conversational framework is that the teaching and learning process is a dialogue, a conversation in which both the teacher and learner participate. Laurillard states that in the university setting there are two levels of conversation for academic subjects. The first level is at the academic level, a shared vocabulary of words, the level of descriptions e.g. mathematical formulae, technical terms. The second level is at a more personal level, at the level of actions. Laurillard believes that the 12 activities that the framework is made up of, must take place in any learning experience, by traditional methods or by computer, to achieve a given topic goal in an academic subject.

Previously conducted research [Montgomery 1996] used the conversational framework as an evaluation tool for reviewing 13 existing higher education Computer Assisted Learning [CAL] packages in order to establish which activities were commonly supported in current higher education packages, which were not developed with an explicit design method. As stated earlier, Laurillard identified four categories of activity important in the teaching and learning process; Discursive, Adaptive, Interactive and Reflective. In the reviews, each CAL package was checked against the 12 activities in each category in order to find out if that category was supported or not. The

Discursive category results made it clear only one side of a dialogue or discussion was taking place. This indicated despite the potential technology has for replacing the one-to-one tutorial [seen by Laurillard as the ideal teaching and learning scenario], CAL in its design has failed to capture this discursive element. Initially it appeared that the Interactive category of activities was well supported in the exemplars, but it is the type and quality of an interaction that is significant, and on close examination some packages' interaction was questionable. Sims [Sims 1995] indicates the importance of this category:

> *"The planning of* [update] *interactivity is extremely important...the quality and format of media as a component of the* [update] interaction *and feedback will affect the overall effectiveness of the instruction."*

Adaptation seems to be a category that CAL should have scored well on but the results did not confirm this. A long history of tutoring systems based on artificial intelligence principles - Intelligent Tutoring Systems [ITS] have always done this rather well. It is probably down to a developer/designer choosing not to include adaptation due to time constraints rather than the technology not allowing it to happen. In the packages reviewed, Reflection was not generally considered. But one Portuguese language package indicated that it was possible[Montgomery 1996]. So in summary, these packages showed Discursive and Interactive to be common categories to support in current CAL packages designed without an explicit design method, although improvements could be made in the quality of the interaction. However the occasional supported activity suggested that other categories are also possible to support. The results of the reviews were then used as the foundation for formulating a new design method suitable for higher education.

The reviews provided motivation for further exploring the use of an explicit design method based on Laurillard's conversational framework. This paper discusses the development of a design method based on this conversational framework. Although still work in progress, the proposed design method is intended to consist of a set of general guidelines for CAL developers, a recommended development process or lifecycle, a library of exemplar packages providing the developer with good implementations of the Laurillard activities and categories, and an evaluation method for the completed package. The guidelines would suggest performing tasks such as, making important design decisions early in the development process, for example, a developer must decide whether the CAL package is the sole teaching method in the whole teaching and learning process, or is it one of many e.g. does it fit with a lecture and tutorial series? or is it the only teaching method for this topic? The guidelines would also provide the developer with guidance on the consequences of their decisions and the impact they would have on their CAL design. Previous research [Johnson 1996] has shown that providing CAL developers with CAL case libraries helps to educate the developer about the graphical representation of the package, the way the package should operate and how the package should be designed. The use of case libraries was also shown to provide a context for developers to think about their own particular CAL design problem and to provide them with some initial ideas on how to solve their particular problem. The same research indicated that in order to provide adequate support for novice developers, the case libraries must be supplemented with evaluation methods for the developer to evaluate their end CAL design. Consequently the proposed design method will include such an evaluation tool. It is proposed that such a design method based on some explicit model of the teaching and learning process would focus attention on key elements of CAL design. This would avoid the weaknesses found in current CAL designs, as indicated by the previously conducted research, quality of interaction for example, and that effective learning design would become more achievable. The talk will present this work in progress, how several teaching scenarios were used to develop the design method and sketch out how this new design method will be evaluated.

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A WWW Client/Server Framework for Educational Software

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Abstract: This paper describes a simple and secure client/server framework suitable for supporting intelligent tutoring systems (ITSs) and other types of interactive help or expert systems. The framework proposed here is particularly well suited for porting existing applications to the WWW, since it divides the application into a Java-based client front end and a non-Java server that could, in principle, run on any platform that supports sockets and HTTP service. A prototype system, PROOFER, which is implemented on a Unix host, illustrates the framework's potential for supporting educational software.

Introduction

As the World Wide Web gains in popularity and influence more and more educators are looking to it as a important medium for the delivery of educational software. There are already a considerable number of educational applications and demonstrations available on the Web with more appearing every day. The development of the Java Programming Language [Gosling et al. 1996], with its promise of executable content, opens up the possibility of new and innovative architectures for educational software. Moreover, the Web's potential for genuine platform independence provides a large incentive for educational software developers to explore Web based connectivity and implementation strategies to support distance learning systems and distributed learning environments. This paper describes a simple and secure client/server framework suitable for supporting intelligent tutoring systems (ITSs) and other types of interactive help or expert systems. A prototype system, PROOFER (http://troy.trincoll.edu/~soar/proofer), which provides help with logic proofs on the WWW, illustrates the framework's potential for supporting educational software.

The Client/Server Model

The client/server model is well understood and programming constructs that support it are available in a number of high level languages, including C, C++ and Java. In a distributed environment, the client and server processes run on different processors that may be located anywhere on the Internet. The socket utility supports dependable two-communication between the interacting processes. Examples of well established client/server applications include the Unix sendmail program for sending and receiving electronic mail, the ftp program for handling file transfers, the telnet application for supporting terminal sessions, and the popular chat applications that support interactive chat on the Internet.

Communication between a client and server takes place over a communication channel known as a *socket*. In order to protect the client's computer against malicious actions, Java applets downloaded over the network are subject to stringent security restrictions. In particular, an applet can only create a socket connection to the computer from which it was itself loaded [Flanagan, 1996].

The PROOFER Service.

PROOFER is a tutorial service available on the WWW (http://troy.trincoll.edu/~soar/proofer) that constructs logic proofs in the propositional calculus. It uses a natural deduction technique of the sort used in many introductory logic courses. Given an argument, PROOFER constructs the following solution, in this case a three step proof of the conclusion *D*.

1. A -> (B & C)
2. A
3. C -> D   / |= D
4. B & C   // 1,2 by modus ponens
5. C   // 4 by simplification
6. D   // 3,5 by modus ponens

PROOFER is implemented on the client/server model. The client process is a Java applet that can be accessed from any HTML document. It provides a simple interface to support interaction with the server process. The client enables a user to type in an argument and submit it to PROOFER, which returns a completed proof. The Java client is event driven and multi-threaded, so that the user can be typing input while the client is receiving a response from the server. The server process is a Soar program that uses pattern matching and inference techniques to construct a valid proof for the argument. It collects each proof step together with its justification and sends the entire proof back to the client, where it is parsed and displayed.

Advantages of the Client/Server Model

Interface vs Expertise. The client/server model provides a secure and dependable communication framework for Internet based educational programs. It is particularly well suitable for applications that require substantial processing power. It also provides a feasible alternative for porting existing applications onto the Web. Rather than rewriting the entire application in Java and downloading it in its entirety, one can implement its interface in Java and leave other portions of it on the server. This is particularly useful for ITS and other AI applications which frequently have a clear separation between interface and expertise. For example, a WWW-based expert system could port its interface to the client side of the model and leave its knowledge base and inference engine on the server. This allows the application developer to have the best of both worlds: a powerful system for developing the interface (Java) and a specialized environment to support its knowledge-based component.

Java and Platform Independence. Using Java and HTML as an environment for the interface provides a number of distinct advantages. First, Java is platform independent -- one version of the software is available to anyone who has a Java compatible browser. Second, Java is a powerful multimedia language, ideal for creating attractive interactive environments. Third, applications written in Java can be distributed through the Web and updates to the application can be made immediately available to all its users at minimal cost. This is an especially useful feature when developing incremental systems. Finally, the browsers that support Java provide excellent security features. This will help reduce concerns that distributing one's educational application in this way will cause problems on the host computer.

Incremental Development. The knowledge and functionality of WWW based applications based on the client/server model can be extended incrementally without having to worry about distributing new versions of the software. This is one of the main benefits of the Web-based client/server framework.

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TEACHING THE TUTOR: ACQUIRING DOMAIN KNOWLEDGE THROUGH INTERACTIVE INSTRUCTION

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Abstract: This paper reports on research that addresses the knowledge acquisition problem for intelligent tutoring systems (ITSs) and other knowledge based systems. Soar Instructable Teaching Architecture (SoarITA) is prototype machine learning architecture that learns part of its task domain by taking instructions from an expert.

Introduction

Intelligent Tutoring Systems (ITSs) and other knowledge based systems are characterized by their representation of domain knowledge in a form that can be processed and manipulated by the system. A main bottleneck in developing such systems is the *knowledge acquisition problem* -- the problem of acquiring and encoding the knowledge base. Most ITSs have relied on some form of preprogramming in which the knowledge engineer acquires the information from a domain expert and programs it directly into the system. This approach is labor intensive and requires a skilled programmer. A teacher who wishes to develop an ITS cannot easily input the required knowledge directly. What if there were a way for the domain expert to teach the system the requisite knowledge? This paper describes a prototype architecture for acquiring knowledge automatically through instruction.

An effective knowledge acquisition tool for ITS, must: (1) acquire new domain knowledge efficiently and incorporate it into an existing knowledge base; (2) be accessible to domain experts without requiring the services of a trained programmer; (3) be applicable to a wide variety of different domains; and (4), support acquisition of all types of knowledge used in an ITS. SoarITA (Soar Instructable Teaching Architecture) is a prototype system that satisfies these conditions. SoarITA is written in Soar [Newell, 1990], a production system architecture that incorporates a very general and robust learning mechanism, and is based on previous work in this area by (Huffman and Laird, 1995). Given primitive operators for a task domain, SoarITA uses inductive learning techniques to build up a hierarchy of operators that can be used effectively in ITSs and other knowledge based systems. The ITS framework being used in this project is part of an interactive learning environment (ILE) for elementary symbolic logic [Morelli, Pelton and Dinkins, 1995].

Teaching SoarITA To Do Logic Proofs

SoarITA's present domain is the propositional calculus, and it contains knowledge about inference rules, premises, conclusions, as well as specific productions that support its tutorial interface (e.g., windows, buttons, etc.) and its tutoring operations (e.g., explanations, examples, exercises). SoarITA is being taught how to do logic proofs. The following example illustrates how SoarITA is taught a new a proof of argument 1, which is shown to the right

1	prove (argument1)	How?	**Argument 1**	
1.1	write (premise1).	OK	1. A -> (B & C)	
1.2	write (premise2).	OK	2. A	
1.3	write (conclusion).	OK		|= C
1.4	apply (modus_ponens,1,2)	OK	3. B & C	1,2 MP
1.5	apply (simplification,3)	OK	4. C	3, SIMP
1.6	finished()	OK		

The first instruction in this case is one that is not built into the system. This causes SoarITA to begin accepting instructions on how to perform the new operation. Since each subsequent instruction (1.1-1.6) happens to be a primitive operator, SoarITA executes it (OK). While it is taking instruction it learns new productions that correspond to each step in the instruction sequence. The *finished()* instruction indicates to SoarITA that the user is done defining the new instruction. SoarITA then adds the new operator, *prove (argument1)*, to its list of built-in operators.

The result of this process is the learning of a new production rules that implement the new operator, in this case *prove(argument1)*. The following production proposes the first step of prove(argument1):

```
if the goal is prove (argument1)
and this is step 1 of prove(argument1)
and argument1 has premise1
then propose write (premise1)
and increment the step to 2.
```

On subsequent issuance of *prove(argument1)* SoarITA will fire the learned productions. The context in which the learned productions can be used is fairly broad and general, since the only contextual knowledge they contain is the goal and sequence number. Thus the command *prove(argument1)* can be used by an ITS within the context of other instructions -- e.g., higher level operators -- including within tutorial contexts. For example, SoarITA has also been taught *teach(argument1)* and *walk-through(argument1)*, both of which make use of *prove(argument1)* and are used in tutorial contexts By using learned operators in this way, SoarITA can build up a hierarchy of operations that together constitute the task and tutorial knowledge of an ITS.

Preliminary Results and Future Work

Learning Task and Tutoring Knowledge. Our work so far indicates that it is possible to teach an ITS the appropriate kinds of task and tutoring knowledge, and it does seem feasible that such a system could serve as a basis for an authoring environment for ITSs and other interactive help systems. There is nothing inherent in SoarITA's architecture that would seem to limit its applicability. Any task domain that could be represented as a state space, with operators that perform transitions from one state to another, could be learned in this way. Some examples of suitable domains would include geometry, algebra and computer programming.

The Knowledge Transfer Problem. To what degree does knowledge learned in one situation transfer to another situation? Preliminary results indicate that certain types of transfer are easy -- e.g., every logic proof starts by writing down the premises and conclusion. But that other types are not -- e.g. the inference rules used in one argument don't easily transfer to another. A major question for the ITS context, is whether any useful transfer can be achieved between learning how to do a task and how to teach the task. Results so far indicate that a modest amount of such transfer does occur.

The Initial Knowledge Problem. It is relatively easy to add new primitive operators to an existing domain and to organize these into hierarchies that represent the domain at various levels of abstraction. This kind of flexibility should lead to ITSs that can be more easily adapted to fit students' needs. For students who have difficulty with high-level concepts, low-level operators can be developed, and vice-versa for students who already know the basics of a domain.

Future Work. In addition to extending SoarITA's task domain and incorporating it into a full-fledged ITS, future work will focus on applying learned productions to student-modeling and other ITS problems.

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Reducing Barriers to Integration of Multimedia with K-6 Science and Mathematics Instruction in Inner City Schools

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Abstract: A three year project has partnered Baylor College of Medicine, the Harris County Department of Education and twelve Houston-area elementary schools in an effort to achieve school-wide improvements in science, mathematics and technology teaching and learning. As part of the project, different teams of 4–6 teachers from partner schools attend a four-week institute on integrating science, mathematics and technology each summer. Results indicate that participating teachers have improved their skills in the areas of word processing, spread sheet applications, Internet applications and multimedia. These results are supported by evidence of changes in attitudes towards the integration of advanced computer applications with science and mathematics instruction. Several program elements have been identified as most important in influencing teachers' abilities to incorporate advanced technologies into their classrooms: non-threatening environment; opportunity to have sufficient hands-on time at computer; opportunities for self-evaluation; year-round support and creation of large teams of teacher-leaders.

As new technologies become standard tools in American schools, teachers must become confident about integrating different applications across disciplines. As has been noted, technology can support, enhance and, even redefine, the jobs of teachers. However, little research has focused on the impact of technology on teachers or on ways to enhance multiple uses of technologies by teachers [OTA 1995]. These themes are being examined in an ongoing project aimed at providing instruction, hands-on experience and year-round support to teachers in inner city elementary schools in Houston, Texas. The three-year project (Harris County Alliance for Science, Mathematics and Technology Education) has partnered Baylor College of Medicine, the Harris County Department of Education and 12 elementary schools in an effort to achieve school-wide improvements in science, mathematics and technology teaching and learning. Technology goals have focused on helping teachers to become confident users and to learn to incorporate multiple technologies, including multimedia applications and telecommunications, into daily science and mathematics instruction.

Unlike suburban schools, inner city elementary schools sometimes have few instructional resources and offer only limited professional development opportunities for teachers. These problems are exacerbated by the lack of exposure of elementary school teachers to hands-on, discovery-oriented approaches for the teaching of science and mathematics. Hence, teachers in urban schools experience the same insecurity about providing hands-on, problem-based instruction in science, mathematics and technology that is shared by the majority of K–6 teachers, in addition to having to deal with many other complex school and community related issues.

A local needs assessment leading to the creation of the Harris County Alliance project pointed to several barriers that impede the incorporation of multiple technologies and telecommunications into mathematics and science instruction in urban Houston schools. These include:

- teachers' lack of basic skills and knowledge about computers (which must be acquired before teachers can access and apply more advanced applications of technology);
- lack of time for teachers to learn, experiment with and implement new software and hardware;
- insufficient opportunities for teachers to receive inservice training;

- insufficient ongoing support during the school year on technology applications;
- personal negative beliefs by teachers about their own abilities to learn and implement seemingly complex technology applications; and
- misconceptions about levels of expertise required for integrating multimedia into daily instruction.

Project activities were designed to meet these needs by improving teachers' skills, levels of self-confidence and leadership abilities. Each summer, teams of 4-6 teachers from each school attend an intensive one-month summer program focusing on integrating science, mathematics and technology. The program is held at a school with extensive science and technology resources and a direct Internet connection. For four weeks, teachers learn inquiry-based methods for teaching science and mathematics and ways in which diverse technologies can be integrated into those subject areas. Mornings are spent in sessions with visiting scientists and educators, and in science labs (grouped by grade level) under the direction of master teachers.

In the afternoons, teachers work in computer labs, where they are grouped by self-reported ability level (novice, intermediate or advanced). Almost half of the participants are novice users, who have little or no experience with computers. A nurturing learning environment is provided for these teachers by an experienced instructor with 3–4 roving assistants. Before more advanced applications are presented, novice users learn basic word processing and spreadsheet operations. After four weeks, even novices are able to incorporate graphics and text into a single document, access resources on the Internet and use e-mail. They explore programs and learning games on CD-ROM. Each teacher in the program maintains a portfolio that documents progress toward a specific goal. Over 75% of the portfolio goals have dealt with integrating technology applications into science and mathematics teaching and learning.

Considerable effort is devoted to boosting teachers' self-esteem and confidence. The grouping of teachers by experience levels in computing labs has encouraged collaboration. In addition, the recruitment of large teams of teachers from each school has helped develop an *esprit de corps* among participants when they return to their home campuses. Each team is expected to provide at least four inservice sessions to other teachers at their home schools. However, they are supported in this endeavor. Harris County Alliance project staff work with teachers in planning and presenting inservice sessions. In addition, project staff provide year-round support in a variety of areas to teachers at each of the partner schools.

Statistically significant gains were measured among summer program participants in 1995 and 1996 in self-reported abilities to use word processing, spread sheet, Internet and multimedia applications. These results have been supported by evidence of changes in attitudes towards the integration of advanced computer applications with science and mathematics instruction. Most teachers were pleased, and even amazed, by the progress that they had been able to make during four-weeks. A majority of participants expressed excitement about returning to their classrooms and implementing new instructional strategies.

Participants and administrators have identified the following elements of the program as most important in influencing teachers' abilities to incorporate advanced technologies into their classrooms:

- provision of instruction in a non-threatening environment;
- opportunity to have enough individual time at a computer to achieve familiarity and proficiency with a number of applications;
- opportunity for self-evaluation of achievement through the creation of a portfolio;
- demonstration "through doing" of the integration of science lessons with CD-ROM and Internet resources or with the creation of multi-media documents and databases;
- provision of differing levels of instruction to meet the needs of teachers at all skill levels;
- provision of support throughout the year on applications of technology; and
- creation of large cohorts of teacher-leaders, who are able to share ideas and support one another on a daily basis throughout the school year.

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Interface Design: Implications for Students with Disabilities

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Abstract: Access to education is a universal right. This simple statement of inclusion is part of the legal requirement of the Americans with Disability Act. More fundamentally, this principle of universal access is an essential standard of an advanced civilization. Historically, however, the inclusion of students with disabilities into traditional educational environments has been done poorly. For many years, students with significant disabilities were relegated to separate facilities. Early efforts at inclusion resulted in integrated classrooms, but frequently, separate instruction and media. Today, as the movement toward fully combined classrooms becomes universal, the need for adapted and adaptable media is clear. Despite a compelling need for instructional materials that work well for disabled students, inclusive accommodations are rarely done properly. Just as no thoughtful architect would intentionally design a building to exclude mobility impaired citizens, no thoughtful information designer would want to exclude disabled users.

Despite legal requirements and obvious needs for universal design considerations, exclusionary design is still common. Why? I would suggest that there are several sensible reason for deficient software - programs which work poorly for students with physical or cognitive impairments.

The traditional reason for restrictive software is cost. To move from simple functional programs to comprehensive flexible systems may require extraordinary increases in effort Furthermore, the needs of a _special audience_ are not clear to designers. Indeed, it could be argued that designers are still struggling with interactive software models which work well for a *standard* audience.

Unfortunately, there appears to be no single point of information as to what legal requirements have been specified to meet ADA regulations. There are no extensive references in HCI texts concerning users with disabilities. Some media developers are reluctant to involve people with disabilities in the process of design and testing - fearful that a Pandora's Box of issues will impact the complex process of system creation.

Yet, the ADA advocates _reasonable_ accommodation - not totally comprehensive accommodation. The legislation describes both "rights and responsibilities" of people with disabilities. Implied, is the participation of people with disabilities in the design process.

This paper presents three basic observations to harmonize short term constraints with long term requirements:

- the aging of the population implies a widening continuum of abilities;
- totally comprehensive solutions are unnecessary if extensibility features are included and access to underlying content is provided;
- inclusive designs are essentially good designs which embody a deeper awareness of principles of visibility, obvious affordances, error correction, and clear feedback.

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An Aging Population - the "Temporarily Able-Bodied"

As demographic shifts in the population predict a larger percentage of older people, and as the need for adult education (remediation and retraining) continues, the _standard audience_ moves in the direction of diminished ability. Older people have less acute vision, hearing, mobility, reduced short term memory, etc. Overall cognitive function may persist at a full level, but at a slower speed. Control of speed may be a critical area in interactive system design. Ironically, more powerful computers have made extremely fast interaction the norm. Yet, current studies indicate that many cognitive deficits are compensated when speed is controlled by the user (or, is intentionally reduced by an insightful instructor). [c.f. "Scientific American" November 1996 - _Dyslexia_ by Sally E. Shaywitz. The article suggest that speed of presentation of text may be extremely important in dyslexia and several related information access challenges.]

Content vs. Format

This primary principle should be inherent in flexible design. Initial creative development works best when content is divorced from a specific presentation medium. Indeed, as the need for cross platform implementation increases, (as re-mediation of material becomes common), effective design tools are still pencil and paper. Or, for collaborative work, a white board and markers. Although there are sophisticated techniques for sharing sketches in a computer environment, the principle of avoiding pathological reliance on a specific software environment is vital. The developments of basic content, generic interactivity, and early usability questions are often best addressed in an environment where revision is a simple as using an eraser...

As many programmers have discovered, the key to effectiveness is intelligent re-use of robust code. If an effort is made to separate content from format, conversions are done more quickly. Clearly, this separation is the intent of markup languages. However, in much current HTML, the text, formats, and images are too closely intertwined - testimony to seductive temptations to embed meaning within the constraints of a specific syntax. The experience of "hard coding" done by early programmers suggests that short term savings are counterproductive when conversions inevitably occur.

Two advantageous side-effects of separating form and content extend software engineering benefits: the ability to extract ASCII text from all content (enabling countless unforeseen accommodation techniques); the option to use automatic forms of redundancy (e.g. concurrent audio and text of the same content).

Hence, accommodations in interface access are less likely to be a retrofit; they are more apt to be the natural extension of an existing structure. Such accommodations may be made by the creator of the package - they may also be made as "reasonable accommodation" by organizations within the rehabilitation community. (e.g. information in a markup language can be sent to a publishing house for blind students and automatically produced in Braille as needed.)

Such standards combined with an awareness that users of educational software tend to be novice users rather than experts, should inform interface developers. Not in terms of a restrictive constraint, but in terms of conventions for inclusion.

Finally, the essential argument of HCI is that we are still in the formative stage of design. We have the opportunity, by involving an increasingly diverse population, to discover within the design process, valuable and universal structures of information access. Just as education is increasingly moving in the direction of collaborative student work - an appreciation of diverse views and a recognition of synergistic cooperation, designers must appreciate universal design principles in the broadest light to brighten the HCI horizon for all.

Teaching Multimedia Systems Design

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Abstract

"Multimedia Systems Design (MSD)" teaches graduate students principles and practice of large-scale multimedia system design. The biggest challenge to teach students how to design and build multimedia system is the *integration* aspect because multimedia systems integrate various computer science areas such as audio/video processing, operating system concepts, high-speed network protocols, user interfaces, and others. Our approach is to apply concepts and examples from these areas to construct a significant project, such as a *digital distributed VCR system*. The course focus is on a large-scale, long-lived software system of a size requiring group effort. In this paper we therefore address the results of this new course, in particular its implication on students' understanding of multimedia systems.

1 Introduction

We have developed a course *Multimedia Systems Design* which we believe fits into the CS curriculum. It introduces new concepts, services, protocols, algorithms and integration of all of them to design and build future advanced multimedia systems. Furthermore, the focus is on the *application* of principles and concepts, and on learning from a single extended experiment. The learning is directed towards construction of significant long-lived, large-scale multimedia systems within a group, as opposed to construction of throwaway examples by an individual student.

The course has accomplished successfully its goals. The students leave the course with a thorough understanding of various areas in multimedia systems, especially their integration aspect. Furthermore, they learn a tool-rich programming environment for building complex audio-visual systems. More important, they have worked on a project of significant scope, built significant software application, and understand the group nature of systems building.

There are not many multimedia systems courses available currently. There exist several courses which emphasize individual parts of multimedia systems (e.g., [Smi95, Row95]. The major difference we see is in the integration aspect of our course and the choice of the project which stresses the importance of the integration (see web page: nahrstedt.cs.uiuc.edu:5000/pub/cs397mm.html).

2 Discussion of the Course

The course presentation was designed so that the covered material would emphasize the integration aspects of the multimedia systems and would properly map to the project design, implementation and testing stages. The lectured material and the project are approached so that they would not become obsolete; the students would get the knowledge and experience with the newest technology, however, would understand the tradeoff among the design choices if certain technology is not in place. The students would be constantly working towards both the development of a project and overall understanding of the multimedia system issues, which would serve them well in both this course, and later courses. The course includes seven basic assignments as shown in table 1. All assignments are group efforts. There are several components we see in this type of a course, namely (1) learning the state of the art in multimedia systems area, (2) experiments, (3) replication of experiments, and (4) observation and deduction.

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Segment	*Description*
1. Project Design	Design GUI and process structure
2. Multimedia Functions	'record', 'play' 'rewind', 'fast forward'
3. Multimedia Scheduling	CPU admission and RM scheduler
4. Client/Server Communication	Client/server protocols for audio/video
5. Lip Synchronization	Synchronization structures, and streams
6. User Interface	User-friendly GUI
7. Integration	Integrate client/server communication with GUI

Table 1: Summary of Course Phases

The results from the class taught in Spring 1996 show that the choice of the VCR application had four positive effects: (1) Students knew this application from their homes, hence the functionality of the application and the goals where clear; (2) The students were not forced to complete the design process before they were ready. Their design process consisted of analyzing new features in the context of their existing software, designing appropriate data structures and algorithms, and implementing the features; (3) The completed VCR application allowed the students to become familiar with most of the aspects of digital video and audio processing and communication. Functional details of compression, scheduling and Internet communication taught students not only the individual areas but also the integration aspect when building a complex distributed multimedia application; (4) Experimentation with digital video and audio within their VCR application was a very worthwhile experience. Especially, because they could mostly hear or see how their design performs.

3 Conclusion

I hear and I forget, I see and I remember, I do and I understand. (Chinese Proverb)

Overall, the course had the following principal accomplishments: (1) The student developed a non-trivial multimedia application, consisting of both techniques and developed skills with digital audio and video. (2) The focus on one significant project brings out the point of *integration*, which is so important in distributed multimedia applications; (3) Forcing integration of new features with previous work also demands that attention be paid to design. Of course, building on previous work shows the value of *re-use*. (4) The course is a system course which brings, similarly to operating systems course, together concepts, approaches, algorithms and structures with real implementation and experimentation on real application.

Acknowledgment

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Collaborative Reflective Practice
A Teaching and Learning Architecture for the Internet

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Abstract: This paper describes the teaching and learning architecture and the results of an evaluation of the first offer of an Internet-based graduate studies program in "open and distance learning" which has been financially supported by the Australian Federal Government, and a global learning initiative from AT&T, and the ICDE. This program is designed to meet the needs of academics and trainers seeking skills in the development of open and distance learning programs. The program is accessible via the Internet and was first offered in 1996. The experiences of the first student intake suggest that the program is successfully meeting an identified need. The program developers describe this program as challenging and clearly trailblazing the push for increasing flexible learning opportunities.

Introduction

Open and distance learning is increasingly becoming a core form of educational activity for instructors in both formal education and work place-based systems. However, many of these practitioners have little or no formal education in open and distance learning techniques. This graduate certificate in open and distance learning is designed to meet the needs of this group of people. Anyone from anywhere around the world with access to the Internet can enroll in the Graduate Certificate if they have an undergraduate degree or equivalent knowledge in the field. The program of study became fully operational in Semester 1 (February) 1997. The technologies and the pedagogical architecture of the program was trialed with a global intake of 25 students from the collaborating institutions in Semester 2, 1996 (July-November).

Instruction Vs Facilitation

There are some fundamental differences between teaching and learning via the Internet as opposed to conventional classroom based processes. Among many other things, the Internet enables written asynchronous communication between participants and within the group. This facility allows for a vastly enhanced teacher-learner engagement and different pedagogical architectures which emphasize facilitation of the learning and study process as opposed to those that emphasize the delivery of subject matter content. The "instructing" teacher expounds, explains, reports, and describes. A lot of this happens in conventional classroom as well as distance education contexts. The "facilitating" teacher on the other hand, functions more like an advisor, coach, guide or mentor who not only presents concepts and organizes the learning environment but also helps learners study, question, reflect on and relate their experiences to others.

The architecture described and evaluated in this paper is a modification of the Kolb Learning Cycle (Kolb, 1984); (http://nexxus.som.cwru.edu/dept/cmost/learn.html). This architecture epitomizes mostly the facilitating role of the teacher in engendering collaborative reflection on practice by learners. Learners access the content on the WWW with a PIN at a secured site at the University of Southern Queensland. This material includes discussion of the concepts and principles including both print and electronic references on them. Learners are required to *study* this material and *reflect* on it. The course content is presented in the form of small chunks of textual information that is hyperlinked and accessible via a set of graphic organizers and also the study chart.

Computer Mediated Communication

Students and instructors in the Program are able to communicate with one another directly (via e-mail) or as part of a group via a computer conferencing software called ABOUT™. This is a Web-based conferencing system which allows easy access to the study materials and the communication channel between and among students. With this system participants are able to send messages to the whole group on matters of common interest to them, as well as to individuals on issues of personal interest.

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Program Evaluation

Feedback from the first cohort of students and members of the program development team was sought on various aspects of the Program. From the students we sought data on the presentation of the study materials on the Web and on accessing of these materials on the Internet; the uses of computer mediated communication for interacting with participants in the study program; and the use of practice-based "reflection in/on action" as a learning and instructional strategy in a computer supported collaborative learning environment. Students were asked to react to several propositions (about 6 to 8) that were presented to them in the form of statements in relation to each one of the issues we raised with them about this mode of instructional delivery. For each one of these propositions firstly, they were asked to indicate their reactions to it on a three point scale like "yes/no/to some extent", or "not at all/to some extent/very much so". They were then asked to explain their responses in a few sentences. From program staff we sought their thoughts on the advantages of the Internet for teaching and learning, amount of time they spent at the peak of their involvement in the project, the nature of their input in the project, and their preparation for carrying out the tasks.

Student Responses

First, we asked students about the presentation of the study materials on the Web. Most of the students said that this mode of instructional delivery best met their learning need as practitioners. Citing time as a major constraint in their working lives, they claimed that the time, pace and place flexibility of this study program allowed them to combine work with formal study in the discipline. Most of them said they had sufficient skills to search for relevant source materials on the Internet and that the problem was not with skills, but with the availability of time. They all thought there was enough information in the Grad. Program documentation on searching for resources on the Internet and that they were able to locate enough resources for understanding of the content of the courses and completing the assessment requirements of the courses in the program. All of the students thought that the sources on the Internet were often of greater value than those in the textbooks in furthering their understanding of the course content. None of them had any real difficulty with communicating electronically but found composing messages directly onto the computer initially somewhat cumbersome. A lot of the problems with composing messages directly on the screen had to do with the editing facilities of ABOUT conferencing system we are using. For most of the students, being able to express their thoughts directly onto the computer was more a matter of getting used to this mode of communication and interaction among peers, than being able to cope with the technology itself. Everyone claimed that the most useful function served by the use of "collaborative practice-based reflection in/on action" was its critical role in motivating them to interact with others in the course.

Developer Responses

The Graduate Certificate Program Development Team was a large group that comprised people from a number of departments and sections in the University. From the members of the program development team we sought responses and their thoughts on the advantages of the Internet for teaching and learning, amount of time they spent at the peak of their involvement in the project, and nature of their input in the project and preparation for carrying out the tasks. The program development staff thought that the presentation of content via the Web and the Internet was valuable, for it enabled lecturers to introduce desirable changes to the content without much hassle. They also thought that Internet-based teaching and learning was tremendously valuable for lecturers as it enabled much richer communication and interaction among participants which is foremost, asynchronous and as such more suitable and attractive for adult learners. Much of the advantages of this mode of learning proclaimed for the students had to do with ease of communication with peers, instructors and access to a richer and more set of all types of resources, as well as management of their registration process. Respondents saw many obvious advantages of the Internet-based teaching and learning environment for the support of students and their learning. These advantages had to do with rapid response to student queries, ability to follow-up actions being taken to address student concerns and queries and a consequent reduction in time wasted at waiting by the telephone for both parties.

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Multimedia in the Science Lab

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Abstract: Many science labs require that students make observations or draw diagrams of what they have seen. Multimedia tools in the science classroom can now help students capture what they see and then revisit it for further analysis. Multimedia can also be used by students to integrate their laboratory work with the content material present in class. This paper provides examples of how students can be more actively engaged in the analysis and synthesis component of the science lab.

Effective use of computer technology in the classroom has the potential to assist children in developing skills to gather appropriate information, problem-solve, and make informed decisions. Also, thoughtful integration of the technology in a class is an important step toward preparing students for the highly technological world that surrounds them. Despite the obvious benefits we do not see widespread effective use of technology across the curriculum. In science courses teachers often talk about technology but unfortunately do not integrate it into their classes [Forbes, 1995]. Part of the problem may be a lack of funding for hardware and software but even well equipped schools are struggling with technology integration.

This lack of integration even when the resources exist may endure simply because teachers see it as requiring great effort for minimal gain. That is, what are students actually gaining from this computer experience? Teachers have been asked to take on more and more duties because of recent cutbacks in education. It seems impossible for these teachers to now find the time to discover how a computer can be effectively integrated into their class. Therefore assuming teachers know how to use the tools, they need to be given some ideas for effective integration. Science classes and labs in particular, can take advantage of spreadsheets, databases, simulations and multimedia. This paper will focus on examples of multimedia and hypermedia activities for science labs. These examples are practical and make use of the computer's unique capabilities.

Digitized video in the science lab has opened up opportunities for new activities. An affordable piece of hardware that has emerged in the last two years has vast potential for our microscopy labs. The QuickCam® recorder from Connectix will plug into the modem port of a computer and can capture color video at a rate of 30 frames per second or it can take a snap shot picture. With this type of technology in a microscopy lab teachers can start to move away from the simple task of drawing organisms seen under the microscope to activities that require more critical analysis of the specimens. For example, a common biology lab involves the examination of pond water. Students are expected to identify the organisms they see. They often look through the microscope and refer back to an identification chart. A problem with this lab however is that it is difficult to follow organisms as they swim out of the field of view. Capturing video of the specimen would provide students with more time to refer back to their identification charts. In this way students can work collaboratively by pointing out features of the specimen as it is viewed on the screen. Such an activity opens up the identification process to discussion. Students justify their rationale and have an opportunity to oppose another opinion. Certainly if more lab time could be devote to this type of discourse it would encourage more analytical thought than the process of drawing the organisms in the field of view.

Another activity, for the same type of lab, would have the students save video segments or pictures of their specimens along with their results to the file server so that other students can view their work.

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Again this provides students with the opportunity to discuss and debate findings but it also let's them see organisms that were not present in their own sample. Certain video segments or pictures could be viewed on a large monitor by the whole class. In many ways this process replicates, on a very small scale, the activities of the scientific community.

With the proliferation of CD-ROMs in the school and home, students have become quite familiar with multimedia. CD-ROM encyclopedias, reference materials, and talking books contain pictures, graphics, video, audio, and animation components. Since our students use these materials frequently in the library it seems logical to now have them prepare their own multimedia lab reports. Multimedia lab reports allow the student to represent their knowledge and findings using a wide array of tools. Complex ideas can be represented in various media forms thus allowing the student the capability of expressing his/her explanations in creative ways. Software such as HyperStudio® and Smart Ideas® (a hyperlink, multimedia, concept mapping program) allow students to easily and quickly construct multimedia representations of their own understanding of concepts. The different format provides new opportunities for students who have difficulty expressing their understanding through conventional means such as oral and written reports. The real potential for the use of technology occurs when students use the tools to reconstruct or represent their knowledge [Jonassen, 1996]. For example, as students progress through a unit on the circulatory system they could gradually build a concept map showing the relationship between concepts. Using a tool such as Smart Ideas® or Inspiration® they would be able to incorporate multimedia components, gathered during labs, into their concept map. Therefore the term arteriole might have associated with it a digitized photo of an arteriole cross section.

It simply is not enough for teachers to know how to use the computer technology. To ensure effective integration of technology teachers will need to share examples of successes and failures. They will need concrete examples of integration that are connected to curriculum topics.

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Creating a Learning Environment on the WEB: Instructional Design Issues

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Abstract

Many educators around the world are discovering the potential use of the World Wide Web as a delivery medium, content provider, and subject matter—providing new ways of designing instruction and new challenges. This short presentation will examine instructional design criteria for developing an appropriate learning environment on the World Wide Web. Technological capabilites, new instructional strategies, challenging role of learners and the teachers will all be examined within the context of a high school level course titled *Instructional Technology 11* presently being developed and delivered on the World Wide Web.

The World Wide Web has provided a new "geography" for learners around the world and a challenge for educators to design appropriate "maps" to help guide them through this vast new terrain. Traditional approaches to designing instruction (e.g., behavioral objectivistic approach) need to be revisited and possibly merged with a more constructivistic approach to form a hybrid model suitable for creating a learning environment on the World Wide Web. Some features to consider for a hybrid model include the following:

- examining the capabilities of the technologies (the World Wide Web as an integration of video, audio, print, hypertext linking, multimedia, interactivity etc.),
- considering new instructional strategies (e.g., more applied and collaborative approaches),

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- examining the role of the learner (e .g., as a creator of content),
- examining the role of the teacher (e.g., as a facilitator),
- different models of assessment (e.g., more applied and authentic assessment).

These features have been implemented within the design and delivery of a high school level World Wide Web based course titled *Information Technology 11*. This course is presently being developed and delivered through the Open Learning Agency in British Columbia, Canada.

Information Technology 11 is designed to encourage students to develop an awareness of the globalization of information and gain mastery of electronic communications concepts. Students taking *Information Technology 11* have an opportunity to complete four modules covering topics such as publishing on the World Wide Web, networking, programming, and multimedia. They have the ability to access the course on the WWW through a password protected system. They work through the content on their own pace, complete a series of hands-on applied activities (learning tasks), and interact with fellow students through an on-line conferencing system. The outcome of the students' work will contribute to the content of the course, thereby providing opportunites for students to be *producers* of content and also *explorers* of content. Students are *facilitated* by an on-line mentor who provides motivation and direction to help them with the learning process through negotiations, monitoring discussions, and project work.

Informational Technology 11 is an example of a course which has *mapped out* some of the new *terrain* using the World Wide Web as a development and delivery model and at the same time adopted a hybrid instructional design model using key features from both the objectivistic and constructivistic approaches.

Designing a Virtual Writing Center for Active Learning: SUNY Empire State College's The Writer's Complex

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Abstract This paper discusses the design of a web-based virtual writing center intended to promote active learning among adult college students doing guided, independent, distance study. We detail the initial idea behind The Writer's Complex, to reproduce the activities that promote active learning in a site-based writing center, and we discuss the thinking and basic research that contributed to the design. We explain first experiences with the center's use and discuss plans for future development.

Background

SUNY Empire State College serves primarily working adults through guided, independent, distance study. A group of faculty designed The Writer's Complex (http://www.esc.edu/writer.htm) as a virtual building that offers similar services and support on the world wide web as a writing center at a residential college, especially including activities that promote active learning.

Writing Center Design

Students can interact one-to-one, on-line, with a text in hypertext format, a text whose pieces create meaning for the student as the student combines its pieces consciously. As [Lanham 1993] states, "the fixed print surface [on the electronic screen] becomes volatile and interactive" (p. 73), making the student a conscious participant in the reading and creation of a text, a first step toward what [Meizrow 1994] calls "discourse," that interior dialogue created as a result of consciously and critically interacting with a text.

Yet discourse involves more than hypertext links. Some rooms offer interactive exercises designed to get the student to think about samples, get immediate feedback for their answers, and self-assess their knowledge, ideally with some critical awareness. Each interactive exercise offers the option of questioning an outcome or getting more clarification from a tutor through electronic mail, shifting the interaction from student-text to student-tutor. The File Cabinet Room supports the same type of critical awareness by providing informed readers' interpretations of texts

The Writer's Complex also encourages discussion of writing through its Escape Clause conference, which offers students a chance to experience the interactive/collaborative style of learning (in addition to the interactive/individualized style that the student-text and student-tutor relationships provide).

Experiences to Date

The Writer's Complex is a work in progress and has been available as a service and a forum on writing for our students. We have done only informal evaluation of its use up to this point, as we have focused primarily on getting the Complex up and working. Our preliminary data spans twenty-nine weeks, from June 16, 1996, through January 4, 1997.

The Complex is accessed on the average of 1939 times per week. Users access a variety of files, an average of 407 different files each week out of a total of approximately 570. Users have most often accessed information on the concept of academic writing, language and writing skills, and sample academic papers.

A shift occurred in early November through mid-December from greater access of menu pages to greater access of content pages dealing with research writing (e.g., citation formats, best sources to choose for particular research papers, etc.), most likely coinciding with student research papers that were due for the fall term. When usage dropped off sharply in mid-December, users went back to the previous pattern of accessing menu over content pages with more frequency.

Users have tended to access the Complex steadily during the day as opposed to late at night and, although information about days of the week is incomplete at this point, more users tend to access the Complex early in the week (Sunday, Monday, and Tuesday).

More important than numbers of persons accessing the Complex, though, is what happens once users are there. It appears as though users are visiting to receive answers to their writing questions more than to discuss the process of writing or their own specific pieces of writing. Although students have successfully created certain strings of discussion, they have not accessed the Escape Clause conference frequently enough to place it in the top 100 documents accessed by count each week, perhaps due in part to the cumbersome nature of the conferencing option. Student comments and other anecdotal information bear out this finding. Though it has taken some time to get started, student-tutor dialogue has been increasing slowly.

Plans for Future Development

We have been somewhat successful at fostering student-text and student-tutor interaction in The Writer's Complex, yet these modes emphasize the individual writer as he/she moves through the process of writing. We plan on implementing two strategies to encourage more student-student interaction in the future, 1) use of the Complex in conjunction with classwork, and 2) space and context for student discussion as the students use the various rooms--no separation of "teaching" and "talking" space, since the teaching occurs through the talking. In the future, we hope to create a community of writers who read and talk--through writing--about the process of writing and thus become active participants in that process.

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HyperClassroom : Networked and Computer-Assisted Learning Environment

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1 Introduction

Tutorial or instructive support for a student by a teacher is strongly desired in both environments of individual learning and collaborative learning. Although the support gives a student the benefits of good understanding, all of students can not receive it at the best chance of understanding for them, especially in a traditional classroom. We propose the idea of HyperClassroom which is a computer software and assists both of students and teachers in both environments of individual learning and collaborative learning. HyperClassroom includes functions of storing the learning behavior record of any student and provides the best learning environment for the student according to own knowledge state timely and seamlessly.

The major theme of this paper is to propose a system which solves the problem when and how the teacher gives a help to the student who gets into trouble or wishes navigation. We call the system REEL (Replacing Environments and Encouraging Learners). The REEL contains Fuzzy reasoning which chooses the best assistant or collaborators and prepares the student the communication channel.

2 Concept of HyperClassroom

As many computer softwares are used in conventional classroom education, the load of a teacher in a classroom are increasing because the teacher must participate in student's performance and gives suggestions, answers questions or undertakes tasks at any time when the student is in trouble. HyperClassroom serves both of students and staffs (a teacher and a few teaching assistants). The mode of communication is image demonstrated on computer displays (CRT). The communication can be attained via computer network. The general learning style of a student is a HyperText-based individual learning by World Wide Web (WWW) services. Other learning styles such as an individual practice or a collaborative learning are also supported by HyperClassroom. The choice of learning style or determining collaborators is mainly done by a staff.

[Fig.1] shows the detail of HyperClassroom. In the figure, three different learning environments, i.e., practice by Intelligent Tutoring System (ITS), HyperText-based learning and collaborative learning are shown. The student's request to a staff can be attained through communication interface and communication server. Three different interfaces are prepared and each learning behavior is recorded in Practice Log, Reference Log or Communication Log, respectively. In order to build the student model, integrated logger integrates the three logs of the student. Similarity of student's behavior is calculated by the Fuzzy reasoning in REEL which uses the log data. Staffs can monitor the similarity and then have the chance of interruption for replacing learning environment when some student requests staff's help or is in trouble.

3 Prototype and REEL

We have designed the prototype of REEL which serves one hundred undergraduate students at a time and four staffs including a professor in a computer classroom. The subjects of 'Introduction to UNIX' and 'Pascal Programming' are the one semester curriculums. The computer system consists of a file server and networked twenty clusters each of which is composed by one workstation and four X-Window terminals. The file server is a workstation which distributes required teaching materials to the CRT of the student and stores the learning behavior record. The similarity measure we introduced here is making use of Fuzzy reasoning[Sangtoki95, Enrique93]. Before we use the learning behavior record, namely student's referencing page and study time, as data for reasoning, we use them to calculate the *appropriateness degree of study time (ast)* and *common referencing degree (crd)* respectively. And then we use them as the input to the Fuzzy Reasoning Engine after the fuzzification process done, due to the data are crisp ones. At the next step, we apply the Fuzzy rules and generate a fuzzy reasoning result. At last, we defuzzify the result to get a crisp final result.

4 Experimental Results

The prototype excluding the systems of the learning action monitor and the cooperative learning support was already available from the last semester and more than 250 students studied each of two courses in two semesters.

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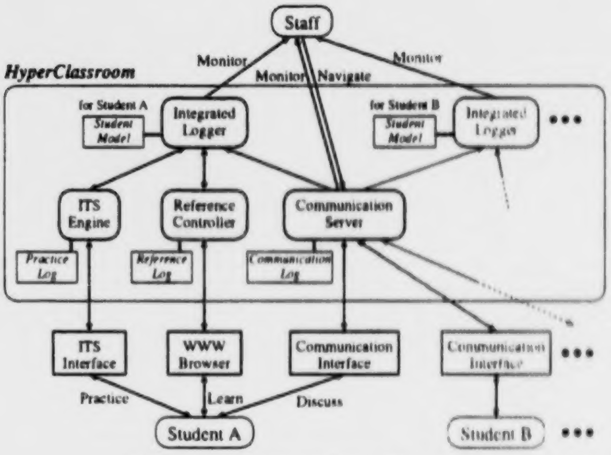
Staff
Monitor
Monitor
Navigate
Monitor
HyperClassroom
for Student A
Student Model
Integrated Logger
for Student B
Student Model
Integrated Logger
•••
ITS Engine
Reference Controller
Communication Server
Practice Log
Reference Log
Communication Log
ITS Interface
WWW Browser
Communication Interface
Communication Interface
•••
Practice
Learn
Discuss
Student A
Student B
•••

Figure 1: Detail of HyperClassroom

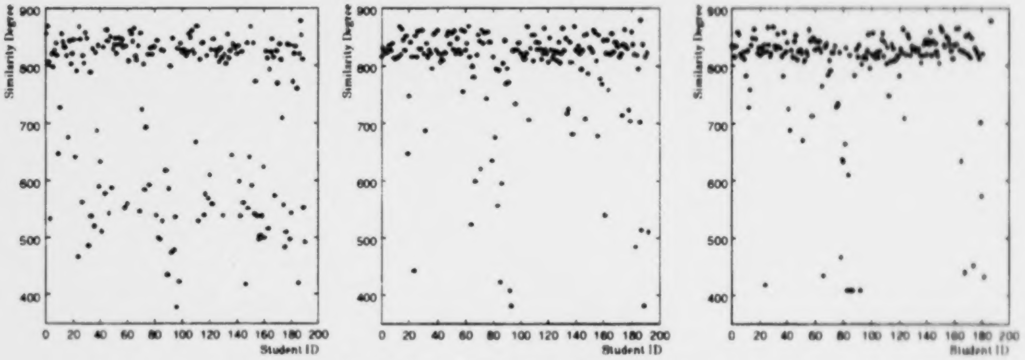

Figure 2: Estimated Result of Similarity Degree

[Fig.2] shows the similarity degree *sd* of almost 200 students in the succeeding three weeks. The topics of each week are E-mail, Netnews and customization, respectively. The *sd* value of most students is between 750 and 900. It means that the student's learning behavior is very similar to each other in every three topics. From the result of similarity degree, the difference of learning behavior between arbitrary pair of students is easily determined.

5 Conclusions

We have proposed the integrated multiple learning environments such as individual learning and cooperative learning and named HyperClassroom. We explained the concept and the fundamental structure of HyperClassroom. Then we introduced the prototype and described REEL which is the system of replacing learning environments and encouraging learners.

The results of measuring the difference of student's behavior from learning behavior records are obtained. From these experiments we found no evident defect of the prototype. Now the prototype only includes the complete versions of two systems in the four fundamental systems. In order to serve students with the best learning environment, we are developing the remained systems.

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A Case-based Pharmacy Environment: Cognitive Flexibility + Social Constructivism

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Abstract: A hypermedia, case-based learning environment has been designed to promote cognitive flexibility in college Pharmacy students. Literature suggests such environments promote complex knowledge structures in students with complex epistemic beliefs, but may cause students with simple epistemic beliefs to struggle. This paper suggests and describes the combination of social constructivist approaches with a cognitive flexibility hypermedia environment to promote learning for students with varying epistemic beliefs.

While it has been shown that cognitive flexibility environments promote complex knowledge structuring in students with complex epistemic beliefs, there is evidence that students with simple epistemic beliefs may struggle with the same materials [Jacobson & Spiro 1995]. This paper describes a hypermedia, case-based environment designed at The University of Georgia College of Pharmacy and suggests the combination of social constructivist approaches with this cognitive flexibility environment will promote learning for all students.

With a key objective of pharmacy education being patient problem-solving skills, the Internet Web Site on Virtual Clinical Applications and Disease Management will expose students to a variety of resources on the Internet that can be used in solving virtual patient case studies. Resource links and case studies are being developed for this learning environment as World Wide Web pages. Students are provided with an on-line case then instructed to explore specific resources selected for that case as well as general resources which may or may not be related to the case. After building evidence and support for an accurate assessment of the problem state, students submit their assessment and treatment plan to the course instructor. Feedback is provided to the students once they have submitted their assessment in the form of a number of potential solutions to the case.

According to [Jacobson 1994], cognitive flexibility theory asserts that students who develop "flexible representations of knowledge" will be able to adapt that knowledge to a wider variety of problem settings (p. 146). Cognitive flexibility theory supports the use of hypermedia for learning and provides several design prescriptions for hypermedia that seek to promote flexible use of complex knowledge in students. Among these prescriptions are: using case studies to learn abstract concepts instead of learning facts that are removed from their context, presenting information from a variety of perspectives and representations, and stressing the complexity of knowledge over the isolation and decontextualization of knowledge [Jacobson & Spiro 1995]. When compared to traditional approaches that call for students to learn information apart from its context, materials designed according to cognitive flexibility theory (e.g., hyper-based cases) have been shown to promote transfer of complex knowledge to new settings [Jacobson & Spiro 1995]. Transfer means students are able to apply new knowledge to a variety of problem settings more readily.

[Jacobson & Spiro 1995] suggest students have different belief systems "related to the acquisition and structure of knowledge," and that these epistemic beliefs can "determine the type of cognitive resources the student accesses in performing learning and problem-solving tasks" (p. 305). The authors tested the hypothesis that students with complex epistemic beliefs who enjoyed active construction of knowledge via complex cases in multiple viewpoints and representations would be more successful with cognitive flexibility hypertexts. Students in an experimental condition receiving a cognitive flexibility hypertext treatment and who were tested to have complex epistemic knowledge averaged higher scores on a transfer-related, problem-solving essay task than students in the same treatment with less complex epistemic knowledge.

[Jacobson & Spiro 1995] point out "further research could collect data on the subjects' hypertext traversal patterns that could help clarify the relationship between epistemic beliefs, learning with hypertext, and knowledge transfer" (p. 327). When compared to their epistemic beliefs and scores on transfer measures, this information could determine whether cognitive flexibility theory is a valid approach for students with disparate epistemic beliefs. If students with simple epistemic beliefs are found to struggle with complex hypertext environments as seems to be the case, [Jacobson & Spiro 1995] suggest further research be conducted to "investigate how students with simple epistemic beliefs can be better prepared to use and learn from..." such instructional approaches (p. 327).

The use of social constructivist techniques (e.g., instructor scaffolding, cooperative learning) might be one way to enhance the performance of students with simple epistemic beliefs in complex learning environments. Combining elements of social constructivism with cognitive flexibility might prove beneficial for those learners unable to cope with complex processing. Where cognitive flexibility falls short of constructivism, according to [Jacobson 1994], is in the provision of social context and collaboration (p. 149). At least three approaches can be taken toward combining social structure with complex hypermedia environments. First, using assessments that measure epistemic beliefs [see Jacobson & Spiro 1995], students with varying beliefs about knowledge can be grouped with the assumption that more naive students would benefit from a pairing with students possessing complex epistemic beliefs. The impact of heterogeneous social grouping in a hypermedia environment was investigated by [Repman, Weller & Lan 1993] who discovered lower ability students may benefit from such a pairing, but with unclear effects on the higher ability students. Second, despite unclear effects of grouping by ability level, cooperative learning still seems to have merit in scaffolding complex environments. [Repman et al. 1993] suggest students working in groups go through a variety of processes such as "mutual guidance" and "disagreement over conclusions and tactics" (p. 286) which help them to restructure their knowledge. Third, the provision of scaffolding can help incorporate social structure into a complex hypermedia environment. A closed listserv used by students and instructors is one part of the pharmacy environment as a forum for questions and communication. The instructor, through responses and promptive listserv postings, will be able to scaffold student problem solving approaches to the case studies. Scaffolding requires that instructors know about strategies and techniques used in specific settings which can be applied to tasks and used to solve problems. Instructors, then, are able to cue and prompt students in the appropriate use of helpful methods and approaches as they struggle to learn confusing material.

Further research is warranted to study the effects of social support structure on students with complex epistemic beliefs who have already proven to be successful in such environments. How might the use of social supports undermine the development of complex knowledge structuring in students? If students rely on social structures too heavily, they may fail to develop the flexible knowledge that arises from active engagement, personal struggles, and trial and error. It seems evident that only those approaches scaffolding student struggles (e.g., strategy instruction) should be used in lieu of methods that lead students to answers not of their own creation.

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IDEALS, A New Environment for Courseware Development, Course Delivery and Training

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Abstract: The Ideals-project, which is sponsored by the European Union, aims at providing a system for flexible, on-demand, telematics based distance learning and training services to Institutes of Higher Education and Small and Medium Enterprises. A Modular Training System (MTS) that allows cost-effective co-authoring of courses and flexible learning for users, has been developed and a European-wide network of Local Training Centres (LTC) will be established. Learners log in, using the WWW, at the server located at their LTC and have access to the whole range of MTS-courses. The LTC also provides on- and off-line tutoring, possibilities for group-learning, records user progress and runs the administration.

Ideals' Modular Training System

The Modular Training System describes the hardware- and software-environment that is used for Computer Based Training (CBT) in the Ideals project. MTS supports in a multi standard technology platform: co-operative courseware production; course configuration; courseware database management; stand-alone learning; group learning; lecturing; administration of courses and course usage and individual user profiling.

Human interaction is assured through MTS' intrinsic communication services such as audio/video conferencing and course sharing mechanisms and in contrast to traditional CBT systems, MTS provides functionality not only for stand-alone but also for group scenarios. Re-use, i.e. upgrading of existing courseware, is easy in MTS and multiple use, i.e. the usage of courseware by many users, is supported. Naturally, all multimedia applications can be used in MTS. Ideals is an open client/server application (see figure 1) that has been designed to operate in nearly all computer and network environments and to grow with upcoming future demands.

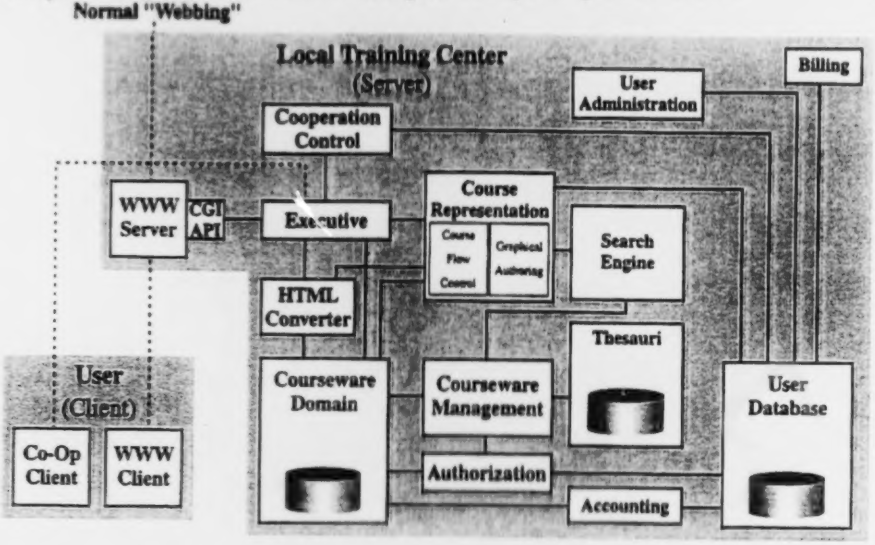
Normal "Webbing"
Local Training Center
(Server)
Billing
User Administration
Cooperation Control
WWW Server
CGI API
Executive
Course Representation
Course Flow Control
Graphical Authoring
Search Engine
HTML Converter
Thesauri
User (Client)
Co-Op Client
WWW Client
Courseware Domain
Courseware Management
User Database
Authorization
Accounting

Figure 1: Client/Server Architecture of Ideals-MTS

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Courseware

Authoring of courseware

The authoring environment is a critical issue in a CBT system. Course authoring is a complex process in which different expert groups need to cooperate. Therefore all participating groups have to be able to exchange annotations to enable teamwork within the production team. Since an intuitive graphical authoring environment is integrated into MTS, teachers and course creators without any programming skills can directly work with the system: layout and design information is integrated into units based on extended HTML so standard tools can be used to create self-contained courseware modules. These modules are checked into the courseware domain database along with a self-description to allow efficient search.

Three universities (Technische Hochschule Darmstadt, Germany; University of Oulu, Finland; University of Coimbra, Portugal) jointly create courseware on the topic *Fundamentals of Computer Graphics*. The universities are linked by satellite and ISDN. The costs and effectiveness of tools for cooperative authoring and on-line communication will be evaluated. In addition to its own courseware, each university uses material produced by the other two universities to build a customised course, resulting in a re-use factor of two (see table 1).

Fundamentals of Computer Graphics (FCG)			
Courseware Producers and Customisers	Equivalent hours of Courseware	Customised Course	Equivalent hours of Courses
TH Darmstadt	6.0	FCG1	16.0
University Oulu	9.5	FCG2	16.0
University Coimbra	8.0	FCG3	16.0
	23.5		**48.0**

Table 1: Cooperative Courseware Production

This pilot demonstrates individual and cooperative course production and configuration as well as individual and group learning, locally and remotely tutored, within a community of about 200 users.

A similar pilot, aimed at SMEs, concerning *Telematics Usage*, is also taking place.

Usage of Courseware

Learning can start right away from the WWW-browser. After login the trainee can start a new course, resume a saved course, issue a training-on-demand request or select a learning group. After working on presentation-, exploration- and examination units the course status is saved and the user profile updated. When requesting training-on-demand a search engine (see figure 1) selects the best fitting course node from the courseware domain and presents this to the trainee. Interactive learning can be added to any type of course usage at any time, either as expert consultation or by joining a learning group.

Benefits Offered by the Ideals-Methodology

Teaching fast developing new technology demands easy adaption of the learning material. In traditional systems changing the contents and/or the courseflow is in many cases impossible. In the Ideals system, tools for the authoring of learning material are integrated into the presentation software (a standard WWW-browser). These facilitate easy adaption of (parts of) the courseware.

Courseflow is user-adapted because the system records the student's progress automatically in a user profile which in turn effects the courseflow. Communication means facilitate group learning, tutoring and cooperative authoring.

Creating CBT material is very expensive. However, the re-use and multiple use of course modules in Ideals considerably decreases the cost of learning material per student while quality is assured by the different authors' specific expertise and the personalized courseflow and tutoring options.

For a more detailed description of Ideals MTS please refer to the Ideals homepage at: http://ideals.zgdv.de

Organizational and Methodological Development of a First-year Russian Course on the Utah Education Network

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Abstract: This paper focuses on the organizational and methodological successes and pitfalls of a first-year Russian course taught over the Utah Education Network in 1996/97. Both on-campus students and distant students from five rural high schools were enrolled simultaneously. Organizational issues included student and faculty training, incentives for faculty, increasing the number of microphones available and the use of fax instead of email. Methodological concerns were difficulties of adjustment to the learning environment, the size of the class, feedback strategies and methods of dealing with student anxiety.

The Utah Education Network provides a two-way interactive television system linking the state colleges and universities and state high schools and regional education centers. A priority of the state is to provide college-credit general education courses to qualified high students---concurrent enrollment. During the 1996/97 school year Southern Utah University (SUU) provided a full year of introductory Russian language courses to students in five rural high schools in southern Utah. For several years SUU conducted general education courses over the Utah EDNET system as well as upper division and graduate level courses but this was the first experience in teaching a foreign language.

Several new technical and organizational issues arose while others that were lingering became even more apparent. SUU was able to deal successfully with some of these concerns while others are yet to be solved. Faculty incentives were a significant issue. Faculty teaching concurrent enrollment are now able to count the course as an 'overload' as well as 'on contract'. Also, we found that language courses require nearly one microphone per student which we were able to provide. It is helpful if distant students in rural high schools are comfortable with the technology before instruction begins. The week before university instruction commences, SUU will conduct a training session for distant students to assist them with obtaining email accounts, information on student support issues, library access, study skills for success in college as well as in a technologically enhanced learning environment.

However, because it is a state-wide system, the receive-site facilitators are not responsible directly to the university and are not always satisfactory. High school bell schedules do not coincide with each other and do not match the timing of our courses.

METHODOLOGY

This language class had a strong emphasis on oral language skills and a communicative approach implies interaction which is naturally more difficult in telelearning environment. Thus, in the course of instruction on EdNet, the major goal was conquering the distance both technically and psychologically. In this regard, works by Barbara McKenzi and colleagues (Mckenzi et al, 1996) and Morris L. Beers (Beers and Orsech, 1996) provided invaluable guidance and insight and helped to avoid or minimize some pitfalls in preparing the course. However, other "gremlins" showed up in the process of course delivery, to name just two most disturbing: adjustment to the new learning environment and increased level of debilitating anxiety.

1. A class comprised of on-campus students (30) and high school students at five sites (28) required adaptation of the course and integration of new media and new teaching strategies to meet student needs. Adjusting to this new technologically-enhanced environment proved to be difficult and often frustrating to both groups as was

reflected in end-of-term evaluations. Additional efforts had to be made to cope with this situation which resulted in slowing down the instruction process. Overall about 15 to 25 percent of time in those type of classes should be planned beforehand for dealing with specific technical and psychological problems, especially in the first course of the series.

In the second quarter the instruction process went much smoother since the students felt more comfortable and relaxed.. They were also used to the structure, procedure and requirements of class which was demonstrated by improved academic performance. The size of the class was another important factor. In the second quarter 31 students enrolled in the course (12 on campus and 19 at 4 sites) which proved to be a more manageable size both technically and psychologically.

Short turn-around times (from students sending assignments to the university until the time the assignment with the instructors' comments and corrections) are of particular importance in effective language acquisition due to the increased danger of perpetuating mistakes. Teaching Russian on EDNET in regard to this aspect was made difficult because of the alphabet differences. Obviously, we couldn't use email which would have required the purchase of special software and training students to use a different alphabet keyboard. The difficulty was solved by using fax to transmit assignments which was a costly operation but necessary for quick feedback.

2. Psychological aspects of this telelearning class were considered of primary importance for its success taking into account communication as the goal of instruction and interaction as a mode of language acquisition. The major issue to be addressed was finding effective ways to deal with debilitating levels of anxiety which are particularly high in the situation of increased interpersonal distance and exposure to several different audiences. The "one classroom" approach was chosen to deal with this issue. Camaraderie is a very important factor in learning a foreign language since "familiarity, trust, and comfort with others act to boost students' certainty that their actions will be well received and their attempts at communication will be welcomed, or at least not ridiculed or scorned." (Pellegrino, 1996 p.7)

Teamwork was chosen as the main mode of classroom activity, which included teamwork at sites and cooperation and interaction between sites. As far as teamwork at sites is concerned, it was successfully developed during the first 3 to 4 weeks. Interaction was developed in the second quarter when students felt more relaxed and willing to interact with other sites. This factor can also be attributed to improved language skills.

An important component in the efforts to minimize the anxiety was the testing technique. Since it is the outcome that is important in foreign language acquisition, the intermediate tests were not graded and students did not gain or lose any points for their final grade as a result of these tests. The test was called "control work" and was undertaken to check language progress. The tests were analyzed in class and the distant students faxed them to the instructor for the second review. That process helped to decrease anxiety and fear of failure and to establish a healthy attitude toward tests, correction of mistakes and progress in language studies.

The year-long course has not be completed at the time of this writing. The final results await analysis at year's end.

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Exploring Personal Identity and Social Justice in 3-D Cyberspace

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Abstract: Internet based virtual reality is allowing students to explore personal identity and social justice on the World Wide Web. Virtual worlds provide unprecedented methods for teaching perspective-taking and critical thinking. Role-playing in simulated environments will become increasingly accessible to educators. The Virtual Reality Modeling Language (VRML) offers exciting new ways to encourage students to actively participate in learning. This paper presents the first steps in Isidore Newman's ongoing work to integrate three-dimensional media across the curriculum.

Multi-user, real-time, interactivity in three-dimensional virtual worlds is now available on the Internet. Access to these worlds is becoming available to a broad range of educators and has the potential to radically change pedagogy. Drawing on lessons I taught 10th grade students at the Isidore Newman School in New Orleans, this paper highlights emerging possibilities created by Internet-based, non-immersive Virtual Reality. In particular, I focus on the opportunities for exploring personal identity and social justice. Yesterday's science fiction is beginning to find a place in today's classrooms. It is imperative that the next generation of teachers and students be acquainted with the three dimensional frontiers of cyberspace.

Participants in virtual worlds invent complex and nuanced fictional identities and interact with other people without revealing their real life identities. Working in pairs, the students created a sociological profile for their character that included the social categories they felt to be most important. This exercise provoked discussion about race, class, gender, geography, sexual orientation, and age. Students struggled to imagine themselves living a life and inhabiting a body very different than their own. Once their character was developed, a new "person" was ready to be born into cyberspace.

Using a shareware Virtual Reality Modeling Language (VRML) browser, my students were able to enter 3-D, multi-user worlds and interact with other people. First, they picked out a 3-D virtual body, called an avatar, that became the visual representation of their character. Then, they created a "public card" that contained information about their character that everyone in the virtual world can access. The body and card express the identity that was elaborated in the sociological profiles. Once a character has a body and a public card, s/he is ready to venture out into social space to interact with others. The students searched the virtual world for interlocutors and engaged in lengthy real-time conversations with people from around the world. Students used these interactions to develop, explore, and further elaborate their virtual identity.

The software we used allowed my students to save transcripts of all their conversations which provided a resource for evaluating the conversations they had. Each student wrote a report about their experiences in cyberspace. They addressed the following issues: Who wanted to talk to you? Who refused to talk with you? Which social categories were most important to you and your interlocutors? When and how did issues such as race, gender, or class come up in conversations? What prejudices did people exhibit? They also addressed issues that related specifically to constructing virtual identities. Would this study be different if you were interviewing people face-to-face? What difficulties and joys did you experience creating a virtual identity? What is the relationship between your real life identity and your virtual identity?

The lesson provided my students with hands-on experience creating social and personal identities. Sociology and psychology are very theoretical disciplines. VRML environments allow students to put abstract disciplines into concrete practice. The practice of inviting students to participate directly in educational worlds can be used effectively across the curriculum. I can image history classes role-playing revolutions, English classes performing collaborative, globally accessible plays, biology classes navigating 3-D simulations of cells, organisms, or ecosystems, and foreign language classes traveling to distant lands and speaking in foreign tongues. Indeed, we may soon participate in academic conferences that take place entirely within 3-D cyberspace.

Young Americans on America: Bridging Cultural and Geographic Diversity

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Abstract: This paper describes a telecommunications project that brought together a network community made up of students from six culturally and geographically diverse American high schools, humanities scholars, and representatives from the Virgin Islands Institute for Teaching and Learning. During a series of video conferences and Internet discussions, participants met to explore the variety of race, ethnicity, and culture that enriches our country and the values that we share as Americans.

Introduction

Young Americans on America: Bridging Cultural and Geographic Diversity, is a telecommunications project which utilized interactive video conferences and Internet technologies to conduct a national conversation among six public high schools across America and the territory of the United States Virgin Islands. Students participated in five one-hour video conferences over a period of five months. Students also had access to a web site that provided discussion forums, chat rooms, and resources on race and ethnicity.

Goals of the Project

The project allowed experimentation with new ways of using technology to further multicultural communication and awareness. The project made it possible for students of various racial, socioeconomic, and cultural backgrounds to interact with others whom they would not have met. Therefore, this project reinforces the purposes of the National Conversation, as stated by Sheldon Hackney, Chairman of the NEH:

> [We]...have a responsibility to examine and discuss what unites us as a country, what we share as common American values in a nation comprised of so many divergent groups and beliefs. For too long, we have let what divides us capture the headlines and sound bites, polarizing us rather than bringing us together [Hackney 1996].

Project Participants

The following six schools participated in the conversation: Charlotte Amalie, Virgin Islands; Fairfax, VA; Boston, MA; Chicago, IL; Austin, TX; San Francisco, CA. The schools were varied in access to technology and socioeconomic status.

Video Conferencing and Conversation Facilitation

The project consisted of six conversations which occurred once a month. Prior to each conversation students were assigned readings and assignments concerning race and ethnic relations. These readings matched the theme for the conversation of the month. In order to facilitate dialogue, one-hour video conferences were used to lead off each monthly conversation. This enabled students to see each other and to converse in real time. A moderator controlled the flow of conversation between the video conferencing sites in order to ensure that each school had equal opportunity for participation. Each one-hour video session began with a ten minute statement from a humanity scholar concerning race and ethnic relations in America. Next, each school was given the opportunity to comment on the scholar's statement followed by open discussion.

In order for students to gain an understanding of the diverse nature of the schools involved in the project, each school took turns in presenting information on their culture and way of life. This along with the reading assignments were designed to facilitate group conversations as well as individual participation. Students indicated enthusiasm about the utility of the video conference conversations. The video conference allowed a unique opportunity to engage in face-to-face dialogue with students from diverse ethnic and racial backgrounds. Students became aware of the value of diversity and its role in American society.

Interactive Web Site and Conversation Facilitation

In order to facilitate ongoing group and individual participation a World Wide Web site was developed for the project. Since each video conference lasted an hour, students were often left with a desire to continue threads of discussion. The web site provided discussion pages to which students could post comments. Students were able to post comments and view previous comments from other participants. This design was effective since students did not have email accounts. A chat room was also available along with a polling section that allowed participants to cast votes on various topics. The web site also provided profiles on each student which consisted of a photograph and a written statement about themselves.

These types of web-based activities enhanced the conversation by allowing students to dialogue during the course of the month. Though some schools were hampered by limited access to the Internet, student participation in the web site was high. The web site provided a much needed support for the video conferences by creating a place for students to meet and discuss issues. Students also liked the ability to find student profiles to gain more information about the other participants.

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Acknowledgments

The project was conducted by the Virgin Islands Institute for Teaching and Learning with funding being provided by the National Endowment for the Humanities' initiative entitled A National Conversation on American Pluralism and Identity. AT&T funded the video conferencing and the web site was hosted by the Institute for Technology and Learning (ITAL) at the University of Texas at Austin.

Special appreciation must be extended to the five Humanities scholars who actively participated in the conversation: Dr. Asa Hilliard, Dr. James Anderson, Dr. Marilyn Krigger, Dr. Waldemar Rojas, and Dr. Richard Spillane. The series was moderated by Dr. Eric Cooper, Executive Director of the National Urban Alliance at Columbia University.

The project director was Dr. Linda Creque, Executive Director of the Virgin Islands Institute for Teaching and Learning. Patricia Platt was assistant Director in charge of technology.

The Role of Visual Testing When Learning from Instructional Multimedia

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Abstract: A field experiment was conducted to test the hypothesis that after completing an Interactive Multimedia (IMM) program, students who receive visual testing will obtain higher achievement scores on identification, terminology and comprehension tests compared with verbal testing. Sixty two post secondary Emergency Medical Services students were randomly assigned to one of two groups. Both groups completed the same IMM lesson and two sets of evaluations. One evaluation was given immediately after the IMM lesson; one group was evaluated by visual testing and the other group by verbal testing only. The second evaluation was given later and the testing modes were reversed for the groups. Data were analyzed using repeated measures analysis of variance and Scheffe´ pairwise comparisons. A significant difference favoring visual identification tests was found. Several plausible hypotheses to account for the findings and recommendations for application and further research are presented.

Introduction

Research into visual testing using paper and pencil techniques has shown that students who receive instruction and evaluation complemented with visual displays achieve higher levels of performance when compared to those who don't receive evaluation complemented with visuals [e.g., Dwyer 1985; Dwyer and De Melo 1983; Dwyer and De Melo 1984; and Szabo et al., 1981]. Are these research findings transferable to learning and evaluation in an IMM, i.e., computer environment? Some research into the role of testing within microcomputer based instruction (MCBI) [Mayton, 1991] suggests that visual testing is just as effective or in some cases more effective in evaluating learning by MCBI.

Visual Testing Theory

Batting [1979] reiterated the concern that any difference between the retrieval environment and the original learning environment produces marked decrements in the learner's performance. Morris, et al. [1977] transfer appropriate principle implies that information processing must be appropriate to the intended use of the information. Tulving and Thompson's [1973] encoding specificity principle assumes that recognition memory is better if the cues used in the original instructional/acquisition environment are used in the testing/retrieval environment. Research by Batting [1979] has shown support for the encoding specificity principle. Paivio's [1986] dual coding theory recognizes both verbal and non-verbal processing and postulates verbal and visual cognitive subsystems for encoding and retrieval of information.

A Field Experiment

A field experiment was conducted to test the hypothesis that after completing an IMM program, students who receive visual testing will obtain higher achievement scores on identification, terminology and comprehension tests compared with verbal testing. This experimental study investigated the effects of two levels of the independent variable, (verbal or verbal plus visual testing) on the three dependent variables, (scores on identification, terminology and comprehension tests). Sixty two post secondary students in an Emergency Medical Services certification program participated in the study on a mandatory basis. Subjects were randomly assigned to one of two research groups. Both research groups completed the same IMM lesson and were then given to two sets of evaluations. One evaluation was given immediately after completing the IMM lesson; one group was evaluated by visual testing and the other group was evaluated by verbal testing only. The second evaluation was given within one to seven days later and the testing modes were reversed for the groups.

The content allowed the evaluation of learning objectives that involved identification, terminology and comprehension and was delivered by a program-directed, self-paced IMM lesson using a multimedia-capable computer which took an average time of one hour. The visual displays presented information that was identical to the text information. Color, audio and dynamic visual displays were used to differentiate various components of a graphic illustration.. Students completed rehearsal activities with corrective feedback. One achievement test measuring identification, terminology and comprehension with visuals used during instruction was developed from the lesson's learning objectives. The verbal version contained only text in the questions and answer choices. The visual version had text information complemented with visuals within the question or the answer choices.

Results

T was no significant difference between standardized means of the verbal and verbal plus visual test groups. There was a significant effect ($\underline{F}$ (1,60) = 32.8, $\underline{p}^{2}0.05$) reflecting that the visual testing mode had a higher mean score than the verbal testing mode for the identification test. A post-hoc Scheffe′ test showed Group 1 and Group 2 visual test scores were higher than Groups 2's verbal test scores. Results indicated no significant difference between groups, testing mode or between groups and testing on immediate or delayed terminology tests. The ANOVRM test results indicated no significant difference between groups, testing mode or between groups and testing.

Discussion

The results of this study lend partial support for part of the study's hypothesis, i.e., students who receive visual and verbal testing obtain higher achievement scores on identification tests when compared with those who received verbal testing.

Several hypotheses to account for the findings have been suggested. They include the type of rehearsal activities used in the IMM lesson, the students' lack of familiarity with visual testing, the relationship between text and visuals, the types of visuals used for visual testing, the high competency requirements of the IMM lesson content and the novelty of learning by IMM. Suggestions for further research were presented.

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Email: The Heroin of Instructional Computing.

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Abstract: This paper addresses the experiences of two multimedia professionals who often use email to communicate with students and commercial clients. Email has become a convenient and powerful means of "conversing" and providing feedback. It examines three key areas: (1) the addictive quality of email, (2) student communication with email, and, (3) optimizing email use.

Electronic mail (email) is often underutilized in the teaching/learning process. This software application is underestimated in terms of its capability. We content that the greatest advantage of email in instructional settings is its use as a feedback medium. The ability to provide immediate and personalised feedback makes email an addictive communication tool.

Email is often the first "networked" application or communication software individuals learn. Many universities assign an email address to each student during their orientation. Once on-line, students find the power connected with the ability to quickly and inexpensively communicate with another individual or multiple individuals addicting.

Initially, the power of email must be demonstrated to the individual. A good means to gain an individual's acceptance is to establish a connection to a list-serve on a topic of interest. Another method is to encourage an individual to find their friend's and families' email addresses. The feedback capabilities of email must also be demonstrated to the individual. Feedback using email is similar to the traditional face to face situation with students and clients. Immediate feedback on performance results is essential for learning to occur.

The use of email with students reinforces the power of email. Although in their study on student attitudes toward electronic mail, Wissick et al (1995) found that students even without high faculty involvement had positive attitudes towards electronic mail, they found students who received more faculty messages were more positive towards electronic mail. The number of email exchanges can be increased by requiring students to converse with the instructor and submit assignments to the instructor via email. Even when the excuse, the network was down, is used the student can always re-send the message. Most email packages save a copy of any sent mail.

To further increase email exchanges, students can be matched with one or more of their classmates to develop a final project in a course. A requirement of at least one email message a week can further stimulate email interactions. . D'Sousa (1991) found that email led to greater communication among class members as well as between the instructor and students. In an Informatics course offered at the UT School of Public Health some "project partners" exchanged as many as ten email messages during week describing their views and ideas on the final project.

During the 15 weeks this course was offered the faculty member and students generated over 1400 messages. The faculty member exchanged at least one mail message, more often two, to each student every week creating a total of 677 messages sent during the 15 weeks. The student responses and interactions generated another 789 messages.

Given this volume of email, the students began to comment on the communication aspects of email beyond the assignment requirements. As they became more accustomed to communicating by email, they needed to be informed of how to use the medium effectively. They began to comment on some common traits running through the messages. They began to notice that some email messages are easier to read and understand than others.

Coaching in the use of the email was given and included: writing a good subject line, line length brevity, terse prose, message length, displaying emotion and common jargon. Specifically, students were given the connections between email and theories of communication and learning. The first component is gaining the viewer's attention. The use of the subject line is considered the "headline" of the email message. A headline's function is to quickly grab the viewer's attention and inform the receiver of the nature of the message.

In composing the message students were made aware of a common email problem - message line configuration differences. One package may allow for an eighty character line length and another may be limited to forty characters. If an eighty character email package is used to send a message to an individual with a forty character email package, the adjustment to the forty character limit can make the message difficult to read.

Brevity is the beauty of email. Students quickly found that very long email messages are difficult to read. To help emphasize the need to keep the message brief, students were introduced to common jargon used in email communications. Common jargon such as ASAP and FYI are easy to comprehend. However, BTW and IMHO are not. These two abbreviations are very common in email. BTW(By The Way), IMHO stands for In My Humble/Honest Opinion).

Again, the ease, the near instantaneous communication, and the lack of "need to purchase" postage stamps encouraged the students to send more messages. As they begin to send more and more messages, the messages tended to become shorter and more succinct. Interestingly, the composition of the messages in the Informatics course while terse and business-like on the project discussion, would overall become very conversational as the weeks passed. Students often composed their email messages the way they would speak to classmates in person. Although they had been encouraged to use the KISS principle in sending email, they began to weave in information on their families, studies and other personal items.

Because of this "personalisation," the need to inject some emotion into the messages lead to an examination of ad hoc email standards. Students were informed that messages in ALL CAPS IS CONSIDERED AS SHOUTING. Smiley faces :-) , frownies :-(, and winkies ;-) are often the first of the emoticons introduced. However there are many, many variation of these they can learn to attach an emotion to a particular paragraph, sentence or word.

Encouraging students to use email as a form of communication is the first step in the "addicting" them to instructional computing. The next step is to build their confidence by assigning specific tasks to be accomplish via email. Finally, providing students with the skills to use email effectively increases the likelihood they will continue to use email in their everyday affairs.

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New Directions for Dealing with Copyright: Archive.edu

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Abstract: Educators at the University of Houston have developed Archive.edu, a Web site that serves as a storehouse of technology-related instructional materials that can freely be downloaded and used without copyright restriction. In addition to being an online resource center, Archive.edu also serves as a gallery for educators and their students to share their projects with the Internet community.

A longer version of this article with illustrations is available on the CD-ROM.

As the World Wide Web continues to evolve, there are a number of issues that are of concern to educators. One important issue is that many schools, districts and classrooms are now developing their own Web sites to showcase the work of students and faculty. This is becoming easier and more common as just about all educational institutions are being connected to the Internet. The creation of Web sites is also being facilitated by the rise in the number of new, inexpensive and user-friendly Web editing programs available on a large scale. The number of commercial Web sites is also increasingly rapidly and this ever-growing abundance of information can be overwhelming for many Web users. The volume of material makes it difficult and often frustrating for users to easily locate useful information. Even with the development of newer and better search engines, many educators do not possess the skill needed to find the information they need. Perhaps most significantly, much of the material that is available on the Web has not been designed for instructional purposes and there still is a lack of ready-to-use resources for the average student and teacher. When educators do find information they wish to use, they must re-design and repurpose this material.

A significant problem for educators is that many, if not most, of the material on the Web is copyrighted and may not be incorporated into instructional projects. For example, the Discovery Channel Web site (http://www.discovery.com/) contains a wealth of valuable resources in the form of text, graphics, audio and video clips. This material may be viewed without restriction, but cannot be modified or reproduced in materials created by students and teachers for later distribution online. The irony of this situation is that the ability to download material is becoming faster and easier as the Web evolves into a more user-friendly resource. To download a graphic, for example, the user only needs to click and hold on the image and a dialog box appears that allows the user to save that image on their own computer. In addition, the Web is rapidly becoming a multimedia-capable environment where audio and video materials can be heard and viewed within the browser itself. This ability allows users to easily save these resources to their own computers, and especially in education, to incorporate these resources into their own multimedia projects.

The Confusion Over Copyright Laws

There has been much discussion recently about what is legal and ethical regarding copying and using works created by others, especially the use of electronic material found on the Internet. The ease with which information may be copied from the Web has forced many developers and users to consider the issue of intellectual property. Copyright laws for the electronic dissemination of information are still evolving, and most educators are unclear about their rights and responsibilities.

Copyright law, simply stated, means that legally one is not allowed to take someone else's words, graphics, video, or any other type of media and use it for their own purposes. However, the long-standing tradition of "educational fair use" allowed many educators to feel comfortable using parts of other people's works for instructional purposes as long as those materials remained within the walls of the classroom. But education today does not always remain within an isolated classroom. Many schools are developing their own Web sites and sharing the work of their students and teachers with the world. A potential copyright infringement problem occurs when, for example, students surf the Web, download graphics or audio clips, insert them into their own work, and redistribute this "borrowed" material on their school or classroom Web site. This situation has forced educators and legal experts to reconsider the issue of what is legal in the world of digital manipulation and electronic publishing.

There are numerous Web sites that deal with copyright and its implications for education. One of the best resources for copyright guidelines and information may be found at the University of Texas Crash Course in Copyright Web site located at http://www.utsystem.edu/ogc/intellectualproperty/cprtindx.htm

What is Needed

With the proliferation of computers within classrooms, connectivity to the Internet, and the desire to produce educational Web pages, teachers and students are searching for ways to utilize technology instructionally. However, a growing body of research indicates that many educators would like to develop multimedia materials that can be used in their classroom but do not possess the knowledge and skills necessary to do so [U.S. Congress, OTA 1995]. The authors have found that many educators are helped by being able to see specific examples of how technology can be used to support the curriculum. Because of the dramatic growth of the Web, many educators are now beginning to think about how technology can be used to motivate students and are seeking models for developing online instructional materials that can be disseminated over the Web.

The authors have been working on the development of a teaching model for developing meaningful instructional projects online. This model has four major components:

- a plan for developing copyright-free resources
- an example of a multimedia project, stack, or presentation
- a description of how this specific example of multimedia is used in the classroom
- step-by-step instructions for creating similar multimedia materials

In most educational Web sites, one or more of these components may be found. For example, there are numerous good examples of multimedia projects on the Web. There are also many theoretical models of how multimedia can be used in education. In addition, there are many Web sites that focus on how to use certain software applications to create multimedia projects. However, there are relatively few places where all of the components, the project itself, how the project can be used instructionally, and directions for creating new copyright-free projects, are found together so that the entire development process is documented and may be studied, not in isolation, but as a complete, integrated unit.

Archive.edu

To continue the development and dissemination of this model and to make instructional resources that educators can use in their classrooms more accessible and downloadable, the authors have created Archive.edu. This Web site will serve as a storehouse of instructional materials on a variety of topics that educators can easily access and have permission to download any of the materials. These materials can be used as they are, or customized and incorporated into other instructional projects. Materials in the archive will supported by other components of the model. For example, not only can a user download an animated GIF file that demonstrates a mathematical concept, but they will also find step-by-step directions for creating animated GIFs, as well as links to related Web resources. The design and development of Archive.edu's interface and information hierarchy has evolved through interviews with educators and students who have expressed an interest in locating educational materials on the Web and plan to use this resource. The prospective audience for Archive.edu includes preservice and inservice K-12 teachers and technology coordinators, university faculty and students, and others interested in educational materials.

Copyright issues continue to be a primary concern for educators who want to use, create and disseminate instructional materials via the Web. Archive.edu is an attempt to solve some of the problems associated with copyright by providing a place where educators can share resources without worrying about violating someone else's intellectual property rights. For Archive.edu to become a truly worthwhile resource, it is necessary that educators can submit copyright-free resources that they and their students create and are willing to share with others in the educational community. The authors and their students have begun the process of "seeding" Archive.edu with useful instructional materials. It is our hope that the Web site will be an entry point for students, teachers and faculty to actively and creatively use technology to develop and share their own copyright-free resources and to take advantage of the collaborative mechanisms that the Web provides. The URL for Archive.edu is: http://www.coe.uh.edu/archive

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Shakespeare's Language: An Interactive Computer Program for Students of Shakespeare's Plays

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Abstract: Most students come to Shakespeare's language prepared to look for obsolete words but not other, more important causes of difficulty: familiar words with unfamiliar meanings, words that contain familiar suffixes with unfamiliar meanings, constructions from which speakers omit words, constructions in which speakers arrange words in unusual ways, words and phrases with syllables or parts of syllables missing, and words with unexpected implications and connotations. *Shakespeare's Language*, developed on SuperCard by Randal Robinson and Peter Holben Wehr, prepares students to recognize and respond to these additional causes of difficulty.

As I learned in doing research for the booklet *Unlocking Shakespeare's Language: Help for the Teacher and Student* (published by the National Council of Teachers of English in 1988), most students come to Shakespeare's language ill-prepared to find the most important causes of difficulty in that language. They know to watch for obsolete words, but not other, more important impediments. These other causes of difficulty we can place under six headings: 1) familiar words with unfamiliar meanings (examples are "abuse" meaning "deceive" and "let" meaning "hinder"); 2) words that contain familiar suffixes with unfamiliar meanings (examples are "awful," meaning "awe-inspiring," and "comfortable," meaning "comforting"); 3) constructions in which speakers arrange words in unusual ways (Othello, for example, arranges words in an unusual way when he says, "That handkerchief / Did an Egyptian to my mother give"); 4) words and phrases with syllables or parts of syllables missing (examples are "'Sblood" and "ta'en"); 5) constructions from which speakers omit words (Perdita, for example, omits words when she says to Florizel, "Now Jove afford you cause" and means, "Now Jove afford you cause for blessing the time"); and 6) words with unexpected implications and connotations (for example, pronouns such as "thyself" and the "me" in "me cranking"; verbs such as "come" and "afford" when they have "let" and "may" implied; and uses of metaphor and personification such as we find in Juliet's "Come, civil night ... , / And learn me how to lose a winning match, / Played for a pair of stainless maidenhoods").

Because most students have not learned to watch for such elements, they usually fail to identify those elements and so fail to work out the true and full meanings of those elements and the passages in which they occur. Consequently, the students become confused but do not know why they are confused, and then, seeking rational explanations for their failures, they conclude that they must be deficient human beings who are simply too stupid ever to read Shakespeare well. They turn against themselves, against the teachers who have led them into failure, and against the language of William Shakespeare.

Peter Holben Wehr and I have developed a SuperCard program (for use on Macintosh computers) to help students adjust to Shakespeare's language. The program, called simply *Shakespeare's Language*, has at its base a scheme of nine classifications. These classifications, which the program introduces through demonstration units and menu items, resemble the *topica* of classical rhetoric. They give students concepts and categories to use in searching, and they help students develop new and necessary mental *schemata* as readers. The short titles for these nine classifications are Familiar Word, Obsolete Word, Suffix, Pronoun, Verb or Verbal, Omission of Syllable, Metaphor or Personification, Arrangement, and Omission of Word.

These nine classifications all hold promises of celebration and assistance. The student who uses them well receives bursts of music, complimentary messages, interlinear translations, explanatory notes, covering fields with words rearranged for lucidity, and similar fields with implied words made explicit. To obtain the rewards that the program keeps in store, the student must first open a cutting from one of Shakespeare's plays (the program provides cuttings from nine plays, and each cutting covers 54 to 160 lines). Then, having read the Shakespearean text, which appears in a scrolling field to the right of the screen, and having read also an introduction to the text made available through a menu, the student must select and classify words and segments with which he or she wants assistance.

The student may select the word "portly," for example, by clicking on it and may then classify that word by using the Familiar Word button on the Palette, which sits at the left of the screen. If the student performs these two actions in sequence, the program will respond with a bit of music and a congratulatory message taken from a speech of one of Shakespeare's characters (for Familiar Word the message is, "A very good piece of work, I assure you"). Then the program will put under the word "portly" the translation "well-behaved," using a color that matches the color of the Familiar Word button on the Palette.

Or the student may select a word that requires a note, not a translation. For example, the student may choose such a pronoun as "thy," such a verb as "afford," such a personification as "night," such a contraction as "ta'en," or such a suffix-bearing word as "awful." After the student chooses and correctly classifies such a word, the program provides not only music and a complimentary message but also an explanatory note in a scrolling information field.

Also, a student may select from the Shakespearean text not a single word but a segment of one-half line to four lines (the program provides the student assistance in locating troublesome segments by listing in its menus the numbers of the lines in which such segments appear). After selecting a troublesome segment, the student may classify it by using the Arrangement button or the Omission of Word button on the Palette. For example, after reading "Were the world mine, Demetrius being bated, / The rest I'ld give to be to you translated," the student might select the second line, classify it by using Arrangement, and then receive a temporary covering field that makes the text read: "Were the world mine, Demetrius being bated, *I'ld give the rest to be translated to you.*" Or, after reading Juliet's "Saints do not move, though grant for prayers' sake," the student might select the second half of the line, classify the selection with Omission of Word, and then receive a temporary covering field that presents this amplification: "Saints do not move, though *they do* grant for prayer's sake."

In using the program in this manner, the student learns a classification system for the difficulties in Shakespeare's language and, by learning that system, learns to fix on elements that most need attention. Furthermore, the student learns to recognize and avoid mistakes in classification that are common among developing readers (the program responds to each mistake by offering short harp-like sounds and a recommendation that the user try another classification). For example, the student learns to avoid treating a familiar word with unexpected meaning as if it were a metaphor, learns to avoid treating an elliptical segment as if it were a segment with words strangely arranged, and learns to avoid treating such a word as "thee" as a word that needs a mere translation.

Then, too, in using this program, the student learns various modes of response for various difficulties. By its translations, explanatory notes, rearrangements, and amplifications, the program models responses that all expert readers practice habitually, sometimes unconsciously. The program also models another kind of response that I have not yet mentioned. Sometimes, after a student clicks on an icon that has appeared above a familiar pronoun, metaphor, or personification, the program puts a series of icons over words related to that pronoun, metaphor, or personification. Thus, the program associates words in a character's speeches or the speeches of two or more characters.

In brief, then, *Shakespeare's Language* helps students discover the pleasures that Shakespeare's plays afford by helping them adjust to the language of those plays. It provides ample opportunities for students to practice significant reading activities, as a mere booklet cannot, and it helps students develop confidence in their own abilities. It also removes the teacher as intermediary and permits the students to become what all students must ultimately become: teachers to themselves.

An Interactive Environment for Digital Electronics Learning and Design

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Abstract: The main objective of Electronic Engineering learning, is the development of the student's capacity for implementing real systems. This supposes the ability to design, simulate and test electronic circuits. Traditional Electronic Instrumentation and professional CAD tools are very flexible and feature a lot of options. Nevertheless, its use in the first course of Electronic Engineering is not adequate because students will never exploit all their possibilities. On the other hand, much time devoted to understanding very complex manuals is required by the students for mastering these tools, slowing down the learning of fundamental design concepts.

By contrast, the use of educational oriented CAD tools, is a suitable solution. They improve the teaching-learning process, offering the same basic options of professional ones and avoiding their drawbacks. In this way, an integrated software package [VISCP (Virtual Instruments & Schematic Capture Programs)] intended to guide students through all stages of electronic systems prototyping, is proposed [Moure 96].

Schematic Capture Program (SCP) of VISCP. Advantages and functionality.

The SCP has a simple interface that allows students to master the program performance in a short space of time. The program operates over Windows environment, where all programs present a similar graphic user interface that makes them easy to use [Alessi and Trollip 1991].

In addition, the SCP is oriented to educational applications. It has been designed to help students in the design task by: 1) preventing typical mistakes in designs carried out by students; 2) avoiding graphical design errors by clearly showing the electrical connections between the system components; 3) allowing students to link their designs with commercial programs.

As opposed to traditional programs, the fundamental components of SCP are standard integrated circuits instead of logic gates [Fig. 1]. This characteristic ensures a direct relationship between the schematic and the real design that the student is going to assemble, making the understanding and test of the circuits operation easier [Mandado 96].

The Virtual Instrumentation Module of VISCP.

The virtual instrumentation technique is based on combining a computer with a simple and general data acquisition system in order to define a specific measuring instrument. In other words, the hardware of the system consists on the proper hardware of the computer plus a general purpose data acquisition system. Meanwhile, the functionality of the instrument is provided by the software. The main advantages of this approach are the following:

- The hardware is common to any instrument so the use of resources is more efficient. Using the same hardware, software modules can be developed in order to generate different instruments like an oscilloscope, a logic analyzer or a multimeter.

- Operation mode is determined by the software. In this way, the control panel can be adapted to the application, according to the requirements of the student level.
- Virtual Instruments use the resources of the computer like, for example, the graphic monitor to represent their results. Using actual multitasking operating systems two screens of different active programs can be represented simultaneously.

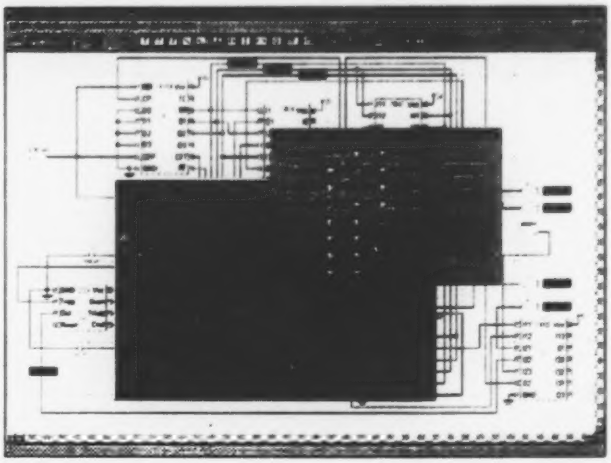

Figure 1: Screen of VISCP.

The virtual instruments can take advantage of real windowed operating systems and the similar interface of its applications. Therefore, if the students need to save some data recorded by the virtual instrument they know that they can find this function on the File Menu of the program. Instead of this, the way of accomplishing the above task in a traditional instrument depends on the manufacturer and the kind of instrument.

Virtual Instruments developed in VISCP are designed to be programmed graphically. For example, logical options are selected using "check-box" controls [Fig. 1]. Also, like in the schematic capture application each control provides a on-line help describing its function.

Multiple instruments of the same or different kind can be created by the student at the same time. The number of signals that can be displayed simultaneously is limited only by the data acquisition system. The same signal can be displayed using different instruments assisting students in the choice of the best instrument for the visualization of a specific signal according to its nature.

Up to now, two virtual instruments for Digital System verification have been developed: a logic probe and a logic analyzer [Fig. 1]. Nevertheless, new instruments can be created by only programming their specific characteristics. The Digital Circuits test is completed with a test vector generator that permits the verification without any external stimulus. In this way, the PC is the unique equipment required for the prototype test.

Due to its educational orientation the Validation tools for the system operation are included in VISCP. These tools use the acquired data as a source to generate a flow diagram describing the evolution of the system. For example, using a virtual logic analyzer and following some rules on signal acquisition the evolution of a F.S.M. (Finite State machine) can be obtained.

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POLARIS:
The Functional Design of an Electronic Learning Environment to support Problem Based Learning

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Abstract:
In this paper the results are reported of functional design activities in the framework of the development of an electronic learning environment. The main function of the electronic learning environment is to support collaborative learning activities in problem based curricula. A review of literature in instructional design and related theories of learning resulted in the determination of a selection of basic instructional principles relevant for problem based learning. An analysis of educational practice was done based on reports. literature and a survey study among all students and teachers in two faculties. The results of this survey study combined with the results of a prior review of research outcomes in computer mediated communication for educational purposes, led towards the formation of the user requirements that are applied in the design of the prototype of the electronic learning environment. POLARIS will integrate tools for information searching, and processing, and a shared database that is used in asynchronous collaborative learning activities.

Introduction

The acronym POLARIS means Problem Oriented Learning And Retrieval Information System. The system to be developed can be described as an electronic learning environment in which the learner can find all the tools that can be used in collaborative learning activities between scheduled two-hour-meetings of tutorial groups that meet twice a week. The kernel of the system will be a shared workplace (database) in which learners report about the results and their progress in individual working on their objectives. Peers and tutors will be able to comment and edit these individual reports (asynchronous collaborative learning by groupware). The electronic learning environment will be accessible 24 hours a day, from the campus (LAN) as well as from the student's homes (TV-cable). The main functions of the system will be:
- supporting learning activities related to information: searching, processing and saving
- supporting the learning process.by communication tools [Ronteltap and Eurelings, 1996]

Principles in Instructional Design for Problem Based Learning

In the analysis of the basic principles in instructional design for problem based learning we connected three elements: knowledge, learning and instruction. In instructional design it is regular to connect the elements of learning and instruction: Instruction is seen as facilitating learning. Developments in instructional technology, however, lead to the awareness that assumptions about the nature and development of knowledge are the beginning of any theoretical foundation of instructional practice. The distinction between information and knowledge, and the emphasis on the social interactions in knowledge construction make constructivism relevant for applying information and communication technology in the teaching-learning process. From two perspectives we examined constructivist learning theories. From the perspective that knowledge is a constructed entity the activities that students perform were accentuated as well as the learnability of construction activities in itself. The third element in our analysis was the social context of learning. The following instructional principles were obtained:

1. The function of a learning environment for the learner is to work in a context where thinking is challenged and assistance is provided in order to become an independent learner, who knows that learning will continue.
2. Knowledge is acquired by active searching and processing of information, directed by experiences in an authentic context.
3. The subject of learning is of equal importance as reflection about the process of learning.
4. Learning is a social activity where individual understanding is the result of agreement about concepts in collaborative working groups.
5. Problem analysis is the stimulus for a self directed learning process, owned by the learner that promotes engagement.

Survey of Learning Activities

These principles of instructional design for problem based learning were the basic elements in the development of a questionnaire in which the actual learning activities of students were examined. The items of the instrument (90) were clustered to aspects of information related activities (searching, processing and saving) and communication activities, related to subject matter or learning process. The questionnaire was sent to all students. Also all tutors were asked to fill in the questionnaire in order to make a comparison between performed and expected learning activities. 671 students and 136 tutors participated in this study.
Summary of the main findings ordered through the learning activities in the instrument:

- *Information searching*: The curriculum as it is presented to the students is not effective enough in producing active and independent information search activities. Skills in information searching, and also the use of tools that are available in the library (catalogues, CD-ROM, Internet) were ranked at a lower level than might be expected.
- *Information processing*: Tutors expect a higher level of goal-orientedness in the learning activities of their students. Students in PBL-curricula do not develop a specific learning style.
- *Information saving*: Students save their information (texts and notes) systematically for later use. However, retrieval of it is often difficult.
- *Communication*: Communication after individual learning remains restricted to the content of learning, students do not report about the learning process. Students do not get individual feedback about their progress in the tutorial groups. Students learn from explaining the content of learning to their peers.

User requirements

The findings of the literature review and survey study were translated to the following user requirements:

- POLARIS must present facilities for an electronic tutorial group in which students and tutors can ask questions and submit answers, display results of learning and discuss these results.
- POLARIS, the electronic learning environment in which students can work collaboratively, must be available between the meetings of the tutorial group. This enables students and tutors to perform activities in the context of learning control.
- POLARIS should support students to access and retrieve information from diverse sources. Search tools must be part of the system to give support to students in their search process.
- POLARIS must support storing and accessing of information. Related to conceptual models of the users a framework has to be designed for the storing and access structure.
- There is a need for coaching by a tutor in the electronic learning environment.

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The Influences of Cognitive Learning Styles on Computer-Aided Learning

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Introduction

One of the most powerful features of computer-aided learning (CAL) is its capacity to individualize instruction to meet the specific needs of the learner. Self-paced instruction, the ability to present content in a variety of ways (e.g., text, video, sound, graphics etc.) and features such as hypertext make CAL a viable learning medium. The use of CAL in education has burgeoned in recent years. Faced with increasing class sizes and heavier work leads, teachers are looking towards CAL as a means of supplementing classroom instruction. In addition, CAL software continues to improve in its ability to engage learners and provide realistic and stimulating learning environments. Educators can now choose from a variety of educational software packages designed to augment the curriculum. However, as will be discussed in this paper, CAL may not accommodate all learners equally, a finding that may have significant implications for education and the future of CAL. Teachers should, therefore, remain cautious when using the computer as a learning tool.

The *Gregorc Style Delineator*

Designed to assess learning styles, The *Gregorc Style Delineator* is a self-scoring battery which focuses on two types of mediation abilities in individuals: perception and ordering. The two dimensions of ordering are referred to as sequential and random; the two dimensions of perception are abstractness and concreteness [Gregorc, 1982]. Gregorc combines these abilities to create four mediation channels of cognitive styles: concrete sequential (CS), concrete random (CR), abstract random (AR), abstract sequential (AS).

People who are dominant CS are usually practical, thorough, well-organized and prefer quiet, stable and structured environments. CS individuals tend to perceive reality as the concrete world of the physical senses and think in a sequential and orderly fashion. AS people consider themselves as evaluative, analytical, logical and prefer mentally stimulating, orderly and nonrestrictive environments. AR individuals are highly focused on the world of feeling and emotion and are sensitive, spontaneous, attuned, person-oriented people. Thought processes of AR individuals tend to be nonlinear, multidimensional, emotional, perceptive and critical. AR people prefer active, free and colorful environments. Finally, CR individuals process information in three-dimensional patterns and think intuitively, instinctively, impulsively, and independently.

Method

The primary purpose of this study was to determine the effects of learning styles on human-computer interaction. To investigate differences between participants, subjects received the same treatment. A CAL program covering 15 steps involved in performing adult Cardiopulmonary Resuscitation (CPR) was designed by the researcher and used to collect data. (The program is currently being marketed internationally to Nursing schools.) Seventy undergraduate volunteers from The University of Calgary (26 males, 44 females) participated in the study.

Independent Measures: The researcher used subjects' highest *Style Delineator* score as a measure of dominant learning style. The following is a breakdown of this study's participants according to dominant learning style group:

CS (20), CR (20), AS (14), AR (16). In addition, subjects' 20 question pre test score was used as an independent measure.

Dependent Measure: Learners were evaluated with a 20 multiple choice question post test.

Research Question: Do learning outcomes differ significantly based on subjects' dominant learning styles?

Results

Learning Outcomes: Results indicated that, as a group, subjects increased by almost two points from pre test to post test, and that means were significantly different between the two tests ($F_{(1,66)} = 57.91$, $p = <0.001$). To examine whether learning outcome differed significantly between learning style groups, a two-way ANOVA (2 X 4 factorial analysis) was conducted. The data revealed a significant dominant learning style by treatment interaction effect ($F_{(3,66)} = 20.11$, $p = <0.001$), indicating that there were significant differences in the magnitude and direction of achievement between the four learning style groups. The mean test scores revealed that three of the four dominant learning style groups showed gains from the pre test to the post test. The AS group increased an average of 3.64 (or 18 %), displaying the highest gain of the three groups. CS and CR groups increased an average of about 2 points (or 10 %). Interestingly, the AR group *decreased* from pre test to post test an average of just over 2 points (or 10 %).

Discussion

The literature suggests that dominance in CS and AS mediation channels predisposes the individual to having a preference for working with computers (be it in the capacity as a computer programmer, or as a learner using CAL software) [Butler, 1984] [Gregorc, 1985] . Randoms are said to find working with computers frustrating [see Gregorc 1985, pp. 202, 20]. In particular, AR individuals prefer human contact throughout the learning process, and prefer engaging in tasks requiring verbal and multidimensional responses [Butler, 1984]. Results from this study are consistent with results found by Davidson et al. [1992]. The researchers found that AR individuals enrolled in a computer applications university course showed significantly lower achievement levels than did the other three *Gregorc Style Delineator* groups. AS individuals showed the highest gains in the course, indicating their ability to work well with computer technology.

Conclusion

Computer-aided learning (CAL) has tremendous potential to provide teachers and industry with a powerful educational tool. However, educators must be cognizant of inherent differences which exist between learners--differences such as cognitive learning styles. Results from this exploratory study show that some learners may have difficulty adapting to computer-aided instruction. It remains essential, then, that the computer be used a tool for *supplementing* classroom activities, not supplanting them. The results from this exploratory study suggest that some learners (AR individuals) may need the support and guidance from the teacher, while others (AS individuals) may be able to learn from the computer relatively independently. Hence, teachers should not assume every student will automatically benefit from computers in the classroom. There remains the need for interpersonal contact and guidance to ensure that all students attain their learning potential.

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This study is based on a thesis entitled " *The Effects of Cognitive Learning Styles on Human-Computer Interaction: Implications for Computer-Aided Learning*" . For more information, please contact the author at the above address.

DEVELOPING A PROFILE OF THE ONLINE TEACHING ASSISTANT

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This paper presents results from the second phase of an ongoing study concerned with the pedagogical needs of online teaching assistants. In the initial phase (Stockley & Rossner, 1996) we interviewed a small number of graduate students teaching online, some for the first time. Their responses to a series of open-ended, experienced-based questions indicated that pedagogical issues pertaining to online instruction need to be identified and addressed. Based on these issues, it became apparent that there is an emerging profile of the online teaching assistant that has yet to be articulated. In this phase of the study, we expanded the pool of respondents in order to extend our database of information about their experiences and will use this data to develop a profile of the online teaching assistant. This profile includes information that addresses the following needs: access and technical training, pedagogical training including instructional planning, implementing appropriate teaching strategies, and evaluating the online student.

Initially, in the absence of well-documented studies, we framed the questions based on assumptions about online teaching derived primarily from anecdotal information available through student evaluation of the courses. Findings from the first study (Stockley & Rossner, 1996) demonstrated that our first assumption, that online teaching assistants had prior technical training, was unsubstantiated. Although, several of the online teaching assistants were familiar with the technology, none of them had received prior formal training before the onset of their course. Our second assumption was that these online teaching assistants were pedagogically prepared to teach online. In fact, they learned by doing. Further, we thought that prior traditional teaching assistant or tutor-marking experience would facilitate effective use of online teaching strategies. We found, instead, that all of the teaching assistants were highly successful teachers online regardless of both prior teaching experiences or familiarity with the technology. Finally, we assumed that attitude toward teaching online and toward technology would play a critical role in their perceptions of the online experience before and after teaching. This assumption was correct. We found that attitude did play a role with respect to the level of personal satisfaction gained or not gained during the course of online teaching.

Methodology

The data collection procedures for this study were identical to phase one, where we asked online teaching assistants to respond to a series of demographic and open-ended experience-based questions. Online teaching assistants were defined as those individuals who had not designed the course, were graduate students, were working under the supervision of a faculty member, and had taught at least half of the course in an online environment.

Participants were initially contacted by phone and then completed the interview questions through e-mail. The questions covered attitudinal transformation from the initial stages of working online through to the final stages of the course. The questions highlighted participants familiarity with the types of technology required and the time spent online. Of particular interest was how the teaching assistant organized the volume of responses received and how they provided substantive feedback to students. Further, we asked if they had advice for others and if they would do anything differently after their online experience. These responses gave the first indication of an emergent profile of the online teaching assistant that is distinct from the traditional conception of their work. The interview responses for this phase of the study were analyzed to determine what patterns of teaching practices emerged that made the online experience unique.

Discussion

This profile includes further analysis of questionnaire data collected from a larger sample of online teaching assistants. Their numbers are not large, but they are growing as more courses and programs offered via online instruction continue to increase. Consequently, the profile we derived from this study is unlikely to be static. Rather, it will undergo continuous revision in ways that address issues noted above concerning access, and technical and pedagogical training.

MAESTRO: Guiding Students to Skillful Performance of the Writing Process

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Abstract: *MAESTRO* is an adaptive writing process tutor for high school level English instruction. The principal factors influencing the design of *MAESTRO* were research results from use of the R-WISE (Reading and Writing in a Supportive Environment) writing tutor, field input from high school English teachers who had used R-WISE with their classes, cognitive research into the writing process, and the cognitive apprenticeship instructional strategy.

The use of computers to teach fundamental skills associated with the production of written text has been the focus of numerous studies in educational technology and applied cognitive psychology over the past 20 years. For example, Zellermayer and his colleagues tested a software writing assistant designed to provide students with writing strategy ideas and facilitate metacognition about writing, two important writing process skills. They found evidence that by using this facilitative software students were able to internalize the guidance and produce improved writing products [Zellermayer, Salomon, Globerson & Givon, 1991]. Similarly, Carlson and her colleagues tested a computer-based writing environment (R-WISE: Reading and Writing in a Supportive Environment) that focused on strengthening critical thinking skills associated with the writing process skills of goal-setting, generating writing ideas, and organizing those ideas into written text. They found that students using R-WISE outperformed control-group students on overall measures of writing quality and analytical reasoning skills, showing performance improvement of between one and two letter-grades [Carlson & Miller, 1996; Rowley, Miller & Carlson, in press; Rowley & Miller, in press].

The *MAESTRO* Design Factors

The *MAESTRO* research program is a follow-on to the R-WISE research with the goal of designing effective facilitative software that guides students to skillful performance of the *entire* writing process. *MAESTRO* uses advanced computer technology designed based on four primary factors: findings of the R-WISE research program, field input from high school English teachers who used R-WISE with their classes, cognitive research into the writing process, and the cognitive apprenticeship instructional strategy.

The first factor influencing the design of *MAESTRO* was previous research with R-WISE conducted with the U.S. Air Force's Fundamental Skills Training (FST) Program, a multi-year research effort to transfer advanced, adaptive training technology capabilities from Air Force technical training research, to public education. The R-WISE software was designed as an adaptive, supportive learning environment for several tasks associated with the writing process. R-WISE was tested and evaluated at 14 high schools in 5 different U.S. States over the period 1992-1996. The primary factors from the R-WISE research that influenced the design of *MAESTRO* were the general approach of the software to teaching writing skills through process visualizations, the designs of several goal-setting activities, and a brainstorming exercise called *Cubing*.

The second major factor influencing the design of *MAESTRO* was field input from teachers who had used the R-WISE software with their classes. Interviews with 25 teachers provided information about the perceived effects of various components of R-WISE on student writing abilities and system capabilities considered by the teachers to be important in the design of *MAESTRO*. The teachers identified as important the ability of *MAESTRO* to provide individualized learner guidance, to utilize a motivational strategy throughout, to allow for a high degree of teacher control over the tutor's operation, and to address the entire writing process.

The third major factor in the design of *MAESTRO* was cognitive research into the writing process. The major components of the writing process include goal-setting, generating ideas, developing a writing plan, translating ideas into text, and revising the text with regard to the original writing goals [Flower & Hayes, 1980]. All instruction, activities, and supporting advice in *MAESTRO* are focused on shaping the student's writing process toward an expert writing process. The student can navigate and perform work in 22 workspaces that simulate tasks performed by the expert writer. *MAESTRO* monitors the student's use of the workspaces in order to determine the level of mastery of the writing process achieved by the students, and provide relevant coaching and advice.

The fourth major factor in the design of *MAESTRO* was the use of a cognitive apprenticeship instructional strategy to help students develop writing process skills in the context of regular writing work [Collins, 1988]. The cognitive apprenticeship strategy used by *MAESTRO* includes using instructional modules to teach tactics and heuristics necessary for proper task accomplishment, sequencing the availability of workspaces from simple to complex based on student writing process mastery, situating the learning and practice in a realistic writing prompt context, using examples to model proper skill performance, and gradually fading the coaching as the student gains competence.

Software Architecture of *MAESTRO*

MAESTRO was written in Multimedia ToolBook 4.0 (Asymetrix) using the Paradox database (Borland). The software was designed using principles of object-oriented programming and an open-ended architecture. The object-oriented design makes the system generic in the sense that the controlling module does not reference specific workspaces by name, but accesses instructional resources based exclusively on rules. The rules allow the tutor to produce individualized instruction, by comparing the student operation of the workspaces with a model of the expert writing process. Because of the object-oriented design of the software, each module within the tutor operates completely independently from the others, sharing only high-level information related to the rules.

Testing and Evaluation

MAESTRO is being tested at 24 middle and high schools in Texas, New Mexico, Ohio, New York, and Pennsylvania during the 1996-97 school year. The current experiment will measure the effects of the tutor on individual student writing products. Ongoing research will identify organizational and implementation issues related to the adoption of the technology by public schools, and provide information on the utility of the design factors as implemented the classroom environment.

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StreamWorks for Distance Education

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Abstract :
The technology revolution in education has already begun. Multimedia, World Wide Web (WWW), video and telecommunications technologies, computer-based simulations, distance learning are a familiar sight in most schools. With a hypermedia environment the role of each element in education field (teacher, student, content) is changing. Many universities use **IRC** (Interactive Relay Chats), **MUDs** (Multi-User Dungeon), **MOOs** (MUD Object-Oriented), listservs or plain email for class discussion and interaction. This paper proposes the concept of ®StreamWorks, the multimedia client/server architecture, which is developed by Xing Technology Corporation. ®StreamWorks is for world-wide and local network delivery of live and on-demand audio/video.

Keywords : Distance education ; ISDN ; Live and On-Demand Audio/Video ; Multimedia system ; Video data compression.

Introduction

Far from being a revolution - as frequently described by the press - multimedia is opening hard and software to new forms of information display, other than text and graphics. We witness the utilization of new media: sound, images, video and, in general, everything that can be digitalised. As a matter of fact, multimedia is neither a new technique nor a specific area of computer sciences. Technical innovation is connected to the possibility to unify production, storage, treatment and transport of all kind of information using the same technological basis represented by digitalization.

Video has become one of the most important media in multimedia applications. Existing "on-demand" multimedia (video) network architectures are based on tightly coupled point-to-point client-server communication, which result in 4 major limitations:

1. significant interaction is required between client and server for flow control, requiring complex server programming and significant data overhead (on the order of 25% - 50%);
2. servers are not designed to deliver the same streams simultaneously to multiple users, making "live" delivery to multiple users impractical;
3. LAN-based server architectures are not designed to operate over wide area networks;
4. communication protocols employed are proprietary, and do not directly support the TCP/IP standard.

StreamWorks represents a significantly different multimedia network architecture, based on the concept of "*streaming media*". This architecture supports both "on-demand" as well as "live" video and audio delivery (in real-time, without having to download first the audio or video file to a local disk drive) which does not require close coupling between the client and server. It easily supports "*multicasting*" and "*unicasting*" of live or on-demand content to multiple simultaneous users over local as well as wide area networks.

StreamWorks Applications in Distance Education

Studies on interactivity showed that a human being can remember only: 10% of what is read; 50% of what is seen and heard; 70% of what seen, heard and read. Accordingly we may say that one of the main multimedia markets is education and training. By his essence and senses the human being is multisensorial, i.e. multimedia. So it is not surprising that today's most used multimedia applications concern education and training.

Research on delivery modes and their correlation to student achievement outcomes has shown that students learn better via teletraining mode than face-to-face instruction [Chute, Balthazar and Poston 89, TFDE 93]. A multimedia educative application considerably strengthens the impact of the studied subject and the interest of the students. The students must take more responsibility for, and be more active in, their learning - whether that means attendance at a satellite downlink site, participation in a class listserv, or delving deeper into a WWW-based lesson.

Due to the development of the intreactive and audiovisual networks, distance education became a reality in schools and universities. The tele-lecture ensures the network distribution of voice, sound and documents. Teaching is dispensed of a particular site and diffused in a lot of other places knowing that interactivity between the sending place and the receiving one is possible. ®StreamWorks is a good solution for distance learning.

Technical Description of ®StreamWorks [Gordon 94]

StreamWorks was developed as a client-server media distribution architecture which can operate independently or complement existing WWW HTTP/HTML architectures on local area networks, private data wide area networks and public data wide area networks (e.g. Internet).

Streaming of multimedia data is a significantly different way of delivery, as the user can view/hear the data as it is being transmitted instead of waiting for file transfer completion, and there is no requirement for complex file systems such as Netware or NFS. In addition, StreamWorks uses standard TCP-IP network protocols, and takes advantage of new "multicast IP" protocols for data delivery, allowing multiple users to simultaneously view/hear the same data streams without duplication of data or use of intrusive broadcast protocols. A typical StreamWorks configuration will include some of the following components: StreamWorks Network Encoders; StreamWorks Network Servers; StreamWorks Network Clients; StreamWorks Network Manager.

The benefits of StreamWorks are : compatibility with existing enterprise TCP/IP networks, including Ethernet, ATM, FDDI, ISDN, T1 and Frame Relay; additional live and on-demand video and audio services to private and public WAN's and LAN's without infrastructure changes; low overhead (3-5%) video and audio streams are fully routable; all network components are SNMP manageable; network congestion is controlled by on-the-fly bitrate reduction of video and audio streams; streams are scaleable from full rate down to ISDN BRI (56-128kbps) and below (as low as 8.5kbps with LBR audio); SQL database management of StreamWorks streams; servers may be distributed for load balancing and stream caching; software-only and hardware accelerated video and audio decode provided on client systems; user interface customizable through HTML/HTTP interface; compressed video and audio streams compliant with MPEG-1 and MPEG-2 standards.

StreamWorks is ideally suited for ISDN remote access server and regional server applications such as distance learning and news delivery, through its ability to provide on-the-fly MPEG stream bitrate reduction and service of large numbers of simultaneous users. Xing is currently developing a reference platform for ISDN regional servers which delivers both high resolution / low frame rate as well as low resolution / 30 frame per second video streams.

Applications requiring "media on-demand" benefit from StreamWorks's simplified approach. The advantage becomes most apparent in applications with a combination of "on-demand" and "live" media delivery requirements, especially when the clients are geographically dispersed[1]. Although commercial broadcast services provide very visible and compelling examples for Xing's capabilities, the largest volume applications for *streaming media* will be in corporate, educational, government and health-care networks with "on-demand" and "live" communication requirements, including training, presentations, and occasionally, entertainment.

Conclusion

®StreamWorks is a development stage architecture that uses a distribution technique to deliver an advanced information management system for broadcasting industry, tele-education and telemedicine. The challenge of ®StreamWorks in teleservices is to enable equity of the quality of services of Telecommunications and Information Technology to citizens in less favored regions, like India or China, where the quality of services varies greatly by region, but where there are some very current communications facilities and infrastructures. New applications are being developed with StreamWorks for distance learning, corporate communications, news delivery and computer based training in corporate, educational, government and health care markets, employing wide area, local area and ISDN networks.

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[1] NBC and Reuters are using StreamWorks to deliver multiple simultaneous live financial and news video broadcast channels to financial market subscribers (money managers, stock brokers, financial analysts) in cities throughout the US and Europe as part of their respective "NBC Desktop Video" and "Reuters Financial Television" services. Xing is developing similar delivery services for other commercial TV and radio programmers.

Creating a Virtual Integrated Learning Environment (VILE)

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Abstract: The increase in off-campus programmes to deliver continuing professional development (CPD) in the higher education sector in Britain has resulted in a growing interest in the use of computer mediated communication (CMC). The use of E-mail and asynchronous computer conferencing to support distance learners is not a new phenomena and the benefits are both recognised and widely reported. [Kaye, 1992] [Mason, 1994]. The writers have adapted the basic desktop provided in Lotus Notes and created a community in which students interact and collaborate at a distance. This paper reports on the development of the Virtual Integrated Learning Environment (VILE) which facilitates an enhanced mode of distance learning.

Introduction

Recent developments in communications infrastructures have resulted in a global technological revolution [Tiffin & Rajasingham, 1995]. The media hype which has accompanied the exponential growth of the Internet with its highly visual point and click interface, multi-media 'plug-ins', synchronous chat and real-time video has somewhat overshadowed the humbler asynchronous media.

Asynchronous versus Synchronous

There is no doubt that the Web is both attractive and powerful but by its very nature is a technology driven environment in a constant state of flux. Programmers, designers and networking specialists are probably able to harness the power of this technology and create highly complex learning environments but such a range of knowledge and skills is likely to be outside of the experience of even the reasonably computer literate educator.

The attraction of a synchronous medium can not be denied but there is evidence to suggest that asynchronous technologies are better able to facilitate the reflective models [Mason & Kaye, 1990] embraced by many CPD programmes. Additionally, the time-location independent nature of asynchronous media [Harasim, 1989] may facilitate greater flexibility and student autonomy. Furthermore, many adult distance learners engaged in CPD programmes are known to study at home and accessing the Internet would normally require them to subscribe to a commercial service. To benefit fully from time-location independence, students should not be required to work synchronously and in the current financial climate they should not have to bear the additional costs incurred by working on-line or paying subscriptions to Internet providers.

The Virtual Learning Community

Adult distance learners place a high value on regular access to tutors and their peers and they benefit from a sense of belonging to a learning community [Gould et al, 1996]. A recent Enterprise in Higher Education (EHE) funded pilot project which examined the use of CMC in support of adult distance learners, utilised the concept of a virtual learning community. This concept is based on the principles of peer exchange, collaborative learning, enhanced access to tutor support and flexibility. Project staff evaluated a number of CMC software products but discounted many because they either resembled a bulletin board environment providing electronic messaging but no sense of a community or there was no facility for off-line working.

Several colleagues had personal experience of working with command line, text based systems such as CoSy and Caucus but considered them to be quite difficult to master and not very appealing.

The software eventually chosen to deliver this concept was Lotus Notes, a well respected and tested groupware product described by the originator as an application development environment. Groupware is essentially any computer application that runs over a network, and/or is accessed by direct dial means, allowing the user group to increase their communication, collaboration, and co-ordination. Lotus Notes is currently one of few products on the market that captures the three main areas of communication, collaboration and co-ordination in one product, and adds to this the ability for customization.

The immediate advantages of Notes appeared to be its availability on multiple platforms in both server and client forms. It is an industry-standard package with a massive international user base providing sophisticated E-mail and conferencing facilities. It appeared fairly easy to operate on the one hand and would appeal to novice users of communications technologies but with infinite possibilities for expansion and development. It was supplied with a number of templates which were customisable to facilitate the development of a range of databases to support conferencing and workflow applications. Unlike many of its competitors, Notes facilitates off-line working with *replicas* of conferences and mailboxes using a remote, direct dial facility with the option of networking and connectivity via TCP/IP.

It was perhaps this apparent ease of use, the attractiveness of the interface and the facility to work completely off-line which appealed most. Using the installation disks as supplied a Notes server and several clients were very quickly established and working perfectly across a Novell network and by remote dial in access using standard modems. A number of trial conference databases were created using the supplied templates and testing of the system began. The setting up of the server and clients was accomplished with a minimum of technical knowledge. The only requirement was for a computing technician to install and configure a card to connect the Notes server to the university's Novell network.

Developing the environment

The original development team of four consisted of three teacher educators who regularly used Windows based products on PC compatible computers, and a resource-based learning development officer. Our initial use of Notes was simply to provide an e-mail and conferencing facility for geographically dispersed students who would be working from their homes.

As the team began to plan for the use of the system by students we identified a number of activities that we would want to support. Printed materials containing in-text activities for each of the units on the programme of study already existed. We decided to use the discussion template to create a conference database for each of these units, tutor group databases and a discussion area for the development team. The same template was used to create a Cafe for social chat, informal exchange of ideas and as a relatively safe area in which both students and staff could practice their conferencing skills. The document template enabled us to create a database where training materials on the use of the system might be stored and accessed by all users. After an initial period of operation another database was created to act as a Notes Help and Advice Centre where common problems and issues to do with the use of the system could be handled.

Unique Features of CMC

The pilot project operated for one year, a number of refinements were made to the system and we began to change the way we approached the delivery of and support to distance learning. Initially, we tried to reproduce our experiences of classroom-based teaching but recognised that computer conferencing impacts significantly on the dynamics of the group and changed the nature of face-to-face (F2F) activities. Additionally, we began to realise that communications technologies provide some unique opportunities for interacting which it would be to everyone's advantage to exploit [Anderson, 1996].

In particular we noted that students welcomed twenty four hour access to the learning community and that the archiving of all discussion produced a much valued resource. These two features alone establish a novel identity for CMC supported distance education in that neither aspect is available in traditional F2F or distance models of learning. The richness of the archived exchanges between participants aided the reflective process and students gained considerably from access to a team of staff who were able to provide different perspectives on issues and problems. There were far more opportunities for students to determine the pace, direction and focus of discussions leading to a more learner-centred approach to distance education when compared with the pre-prepared texts that had previously supported the programme.

Based upon what has been learnt we have now developed a customised Notes desktop with databases that combine together to give the impression of a virtual community. By employing selected aspects of the Lotus Notes applications development environment and exploiting the unique features of asynchronous CMC we are able to support innovative forms of teaching and learning at a distance.

VILE

This new Virtual Integrated Learning Environment (VILE) consists of classrooms where a range of activities and discussions occur, an electronic resources centre to which both staff and students contribute, a tutor-free student common room for social chat and virtual coffee, a staff room for on-going curriculum development meetings, a mail room and an advice centre. VILE supports a new mode of distance learning which possesses some distinct advantages over both traditional and synchronous models. This new environment is currently being used to deliver three CPD programmes. There are plans to conduct a number of action research projects to examine in more detail the significance of the impact of CMC on distance education. We intend to exploit the unique features of CMC in the design of new curricular and to further develop the concept of VILE.

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Exploiting Groupware Reveals an Enhanced Distance Paradigm

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Abstract: A recent pilot project at the University of Greenwich in London reported that employing groupware in the form of Lotus Notes was able to provide a technological solution to some pedagogical problems. It enabled adult distance students to study within an enhanced Time Location Independent (TLI) context with opportunities for regular peer and tutor interaction, collaboration and reflection [Gould et al, 1996]. This paper outlines the reasons for using groupware on an existing distance programme, presents some student and tutor feedback, compares aspects of the system employed with traditional distance and face-to-face (F2F) models and postulates an enhanced distance paradigm.

Context

The project involved adult students engaged in an in-service teacher education programme operating at a distance. The programme was previously delivered using a traditional model involving printed materials containing in-text activities, occasional study days at a central location and telephone tutorial support. In common with many programmes based on this model there are few opportunities for peer interaction or collaborative learning, little sense of belonging to a group or institution and contact with tutors may be erratic and at times difficult [Ryan, 1994].

The model of in-service teacher education favoured by the School of Post Compulsory Education and Training (P.C.E.T.) is based upon a series of interactive opportunities that enable learners to engage in *reflective conversations* [Schon, 1983] and demonstrate progression through an experiential learning cycle [Kolb & Fry, 1985]. Interaction, the sharing of expertise and peer tutoring are considered to be essential ingredients of a programme based on the concept of the reflective practitioner but independent, distance study removes many of the interactive elements of professional learning implied by the reflective practitioner model [Kolb & Fry, 1985].

Computer Mediated Communication (CMC)

An earlier report [Ryan, 1994] had suggested that computer mediated communication (CMC) might address the shortcomings of the traditional distance model by providing an environment in which individual students could interact, providing a collaborative forum for the reflective conversations and improved access to tutors. We believe *interaction* to be one of the key features of CMC because, "where opportunities exist for interaction in learning situations at a distance, it helps learners to make leaps in their understanding that are unlikely to occur when working in isolation". [Owusu-Sekyere & Branch, 1996a] We also agree that, "The asynchronous, text based format of computer conferencing offers a better opportunity than the other conference media for reflection on participants' contributions ...." [Laurillard, 1993] and chose Lotus Notes, a *groupware* product utilising a database structure which combines the functions of communication, collaboration and co-ordination.

The facility within Notes to develop an integrated learning environment using a range of purpose-built databases provides a structured and secure virtual learning environment in *replica* on every student's computer so they may interact with it and other users as often as they wish without the need to connect to a remote server.

Unique Features Emerge

Initial feedback from students indicated that they welcomed the opportunity to exchange ideas with their peers and appreciated being able to ask for and receive almost immediate support from tutors, twenty four hours a day. Additionally, students reported that they felt they got to know their peers and tutors and recognised personalities despite most communication being mediated by computer. In evaluation questionnaires they wrote about feeling as if they were actually attending the institution and made reference to being part of a *learning community*.

Where these distance students made regular use of the system both their ability to reflect on actions and to communicate these reflections in writing were greatly improved. The facility to work entirely off-line on *replicas* of conference databases was considered to be a considerable advantage. The archive of conference entries, which was hierarchical, threaded and indexed, also provided the students with a valuable resource which it is believed further enhanced opportunities for reflection. Combined with twenty four hour access to the learning community these students were able to benefit from features not present in either traditional distance nor F2F modes of delivery.

Another unique feature of this CMC enhanced distance model was the potential for two tutors to *team teach* a unit. This provided opportunities for students to receive inputs from two different perspectives and for the staff concerned to collaborate and support one another. Tutors were able to be more responsive to student needs and questions as they arose making the discourse more *student-centred* and needs driven than in a traditional model of distance delivery.

Feedback from the tutors indicated that they felt as though they were managing a group of students as in a F2F class rather than a number of individuals as is usually the case within traditional distance tutoring. Patterns of interaction closely emulated those found in F2F classrooms [Owusu-Sekyere & Branch, 1996b] with the added advantage that students and staff did not have to be physically present nor connected to the system at the same time as would be the case with synchronous conferencing.

Models Compared

Traditional distance learning involving the use of printed materials and telephone tutorials is known to be an isolating experience for many students as there are rarely opportunities for on-going access to or collaboration with other learners and the tutor. Consequently, there is little discussion and team teaching is not possible except insofar as materials may be the product of more than one tutor. Such a model of learning is deficient in those particular attributes most needed to support the preferred approach to in-service teacher education expounded by P.C.E.T.

If one compares CMC with F2F teaching it is evident that it provides some opportunities not found in the physical classroom. The latter tends to operate to a timetable (time/location dependent), can usually not provide participants with sufficient time to reflect on learning and whilst quality discussion may take place it is usually transitory in nature as no recording device is normally used to capture student exchange and tutor input.

In this pilot project it appeared that applying CMC to an existing traditional distance model of teacher education has enabled students to interact with tutors and peers, feel part of a learning community and use the archived conference material to enhance the reflective process. They have been exposed to team teaching at a distance and to opportunities to collaborate. The content and pace of the curriculum has become more student-centred and all within a context which is Time-Location Independent. There are sufficient unique differences between CMC and traditional distance models to suggest that what we have observed in action is an enhanced paradigm of learning [Harasim, 1989] in which the novel features are related in part to the CMC system adopted.

Conclusions

Our experience suggests that exploiting groupware has revealed a CMC enhanced model of distance learning which appears to address the pedagogical problems formerly encountered when a traditional distance model was employed to deliver in-service teacher education. In addition it has provided students and staff with some unique opportunities that do not exist in either traditional distance nor F2F modes of delivery currently used within P.C.E.T

It is recommended that these unique characteristics be explored and exploited to further enhance the experience of students engaged on distance teacher education programmes. It is further suggested that this enhanced paradigm may provide opportunities for off-campus learning that were not previously thought possible within a traditional model of distance education.

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Interactive Multimedia Software for Elementary Education in Earth and Space Remote Sensing

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Introduction

Today's action-packed computer games captivate students in grades K-6. Young students demand fast-paced games that deliver high adventure, plus exciting audio and visual stimulation. Future educational software will have to compete for the attention of this especially demanding audience. Fortunately, we have the answer in interactive multimedia (e.g., images, text, animation, audio, video). If done right, educational multimedia can grab and hold the attention of these youngsters as effectively as computer games.

Our objective is to test the ability of multimedia to enlighten elementary school students about remote sensing. Elementary school is a critical time for students to form opinions about science. The language and content of educational software for older students are often inappropriate or unappealing to younger students. We hope to use multimedia to accomplish captivating a student's attention while applying the science to real-world applications. Combined with multimedia, science taught using images of the earth and planets attained by remote sensing can grasp the attention of elementary school students. Geography and earth science lessons can be powerfully reinforced through satellite images. Students can view damage from floods, volcanic eruptions, and droughts. Muddy drainage into lakes, resulting from poor agricultural practices, and deforestation are all discernible from space. An effective multimedia package can complement the science curriculum by providing a context to real-world applications.

One of NASA's stated goals is to support general education by distributing information obtained from its scientific missions both to schools and to the general public. Dramatic images, graphics and video from NASA can play a powerful role in introducing young students to real-world applications of science. Our interactive multimedia package for elementary education in earth and space remote sensing will contribute to these goals.

Background

A prototype software package, created using Hypercard, was discussed by Masuoka et al., 1996. This prototype has been reviewed for content and approach by several teachers. These teachers have expressed an interest in using the package in their classrooms and have suggested ways to make it even more useful in complementing their lesson plans.

Our interest of appealing to a younger audience led us to develop a second software package geared toward elementary school students. A different multimedia authoring tool, Macromedia Director, was chosen to create a more sophisticated package. The current prototype is the basis for an elementary level multimedia package under development. The topics covered in the package will be:
How are remotely sensed images obtained and what are their characteristics?
What are the physical features being observed?
What are the issues that are being addressed through remote sensing?

Developing the Multimedia Package

Developing the multimedia package requires expertise in diverse fields. To achieve this, our team consists of remote sensing experts, educational experts, and interactive multimedia experts. To address the attention span issue, the package must go beyond the electronic multiple choice tests and slide show formats typical of many educational programs. The primary challenge in developing the package is recasting the scientific information provided by remote sensing experts to an elementary school level which can be incorporated in the classroom.

Teaching using multimedia has few resemblances to traditional teaching methods. Most curricula are structured in a linear fashion – each lesson building upon the previous. Multimedia is by nature non-linear. Non-linear methods can create an interactive environment appealing to the different modals of learning. This non-linear, interactive approach must be structured carefully because while grasping their attention, it can also divert the student from the desired task. Our package will provide short linear lessons via video and animation incorporated within a broad interconnected pattern of information. The interactivity and the ability to add alternate explanations or stimuli, without cluttering the content, is one major advantage multimedia has over traditional textbooks or videos. Such a package can function one-on-one, as well as providing visual elaboration of complex concepts for incorporation into a teacher's more formal lecture.

The multimedia program is being developed primarily using Macromedia Director. Images are obtained from researchers and from donations from private companies. Elementary school earth science curriculum is used as a reference to incorporate the package into the classroom. The resulting package is tested periodically during development to obtain feedback from teachers and students and to ensure desired performance.

Description of Package

The package will focus on three main areas: 1) what remote sensing is; 2) understanding light; 3) real-world applications. First, will be a broad overview and a definition of remote sensing. Why remote? What can remote sensing show us? A problem solving activity using images will reinforce the comprehension of remote sensing. Second, an understanding of the fundamental properties of light is needed to understand how remotely sensed images are obtained. Activities will include experimenting with filters, and an on-screen simulation of photography. The third area is broken down further and looks at real-world applications using different forms of remote sensing. The activities will use specific examples prompting the interpretation of data, recognition of patterns and problem solving. These examples also give context to specific science disciplines such as geology, biology, astronomy, cartography, hydrology, and glaciology.

Each concept will be approached using a similar sequence. First, relating the concept to the student's existing knowledge base. Each remote sensing concept will be explored using video, graphics, and animation. The next step is an interactive excercise which will evaluate their level of understanding. If the response is correct, a special activity will follow. An incorrect response will prompt an alternate explanation instead of reiterating the previous ineffective sequence.

Future Plans

The remote sensing multimedia package will be completed in the coming year. The final package, including a teacher's supplement, will be distributed to schools at cost on CD and for free on an ftp site. Portions of the package will also be converted to HyperText Markup Language (HTML) format for our World Wide Web site.

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Telematic Learning Environments as an Alternative to Promote Deafs' Communication

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Abstract: The possibility to create "virtual classrooms" or "virtual schools" which Internet, allows to break the isolation of those who due to physical and social barriers are forced to interrupt their education due to lack of special schools which provide them possibilities to a continuous personal and professional growth. This work focuses the potential of computer network using the philosophy of "learning to communicate and communicate to learn" investigating ways to use such resources with deaf ' youngsters. In the cyberspace we have created an environment of telematic learning to promote the communication among such students within our country (Brazil) and people abroad. The interchange of information through dialogues, discussion about topics of particular interest, the construction of cooperative material, among others, have taken place, and have as their main objective to develop the linguistic competence in writing. We here present this experiences and some observed results.

At the entry of the new century we live in a society very strongly information oriented. The most important things until now used to be to own and to control information. Nowadays, however, other aspects more related to the updating and to the speed with which the production and interchange of information are emphasized. Within this context, we seek for media support, and consider telematics one of the most powerful ones. The use of informatics and telecommunication together is transforming the world into a global village and changing the concept of society.

Due to the kind of communication and access of information that is occurring - the so called *"telematic culture"*- we seem to be walking towards new concepts and values including *"countries without frontiers"*, *"democratization of information"*, *"socialization of knowledge"*, among others.

In this same direction, the meaning of educational institutions have also changed. *"Virtual schools"*, *"virtual classrooms"*, *"virtual educational centers"* have appeared, openning new educational possibilities, even to those who are not able to be physically enrolled in the conventional school system.

This new context offers a very important perspective for the handicapped. The importance of such technology for the special education area has been highlighted. Special education is pointed out as being the most impacted area by the tehcnological advances and applications which are taking place as attempts to meet the specific needs of individuals with mental, physical-sensorial and motor limitations or deficiencies. Such applications are promoting changes in the social and affective dimensions of the individuals.

Part of our work, which is all related to the use of Information and Communication Technology in Special Education, focuses the potential of computer network using the philosophy of "*learning to communicate and communicate to learn*". At this moment, we are investigating ways to use such resources, specially the electronic mail, with deaf children and adolescents and cerebral palsied youngsters. In the cyberspace and using the "windows to the world" metaphore, we have created an environment of telematic learning including resources to promote the communication among such students within our country (Brazil) and people abroad. The interchange of information through dialogues, discussion about topics of particular interest, the construction of cooperative material, among others, have taken place, and have as their main objective to develop the linguistic competence in writing.

The possibility to create *"virtual classrooms"* or "*virtual schools*" which Internet makes possible, allows to break the isolation of those who due to physical and social barriers are forced to interrupt their education due to lack of special schools which provide them possibilities to a continuous personal and professional growth. This situation does not allow them to become integrated and to be productive in society.

Using a learning telematic environment in our Center , we carry out studies and experiences which aim to explore the telematic network resources with handicaped. We here present more specifically the work with deaf children and youngsters which emphasizes the interaction/communication process involved in the interchange of information and the cooperative production of written material (such as telematic newspapers, cooperative stories, messages among pen-pals).

The *objectives* of such work are:

(1) to study the possibilities of telematics, particularly electronic mail, in the communication and interaction process among deafs;

(2) to develop alternatives of interaction/communication and to give access to information by promoting the interchange of messages among deafs in Brazil and abroad. The main aim is the production of cooperative materials in a telematic learning environment;

(3) to develop intervention strategies involving writing, related to the communication difficulties of deafs;

(4) to observe and evaluate the effects of the telematic learning environment on the process of interacion/communication and the production of information of the deafs.

The study involved nine deaf students from different schools of Porto Alegre, the state capital, between 9 and 24 years old.

The students attended our lab once a week and worked during three hours. Observations of 18 months of work were recorded.

The activities involved access to Internet, initially in text form using the Telix system and later, using the graphic environment through Netscape. In addition to the access of information allowed by these systems, we emphasized writen production strategies using mainly: electronic mail - interchange of messages with virtual friends with or without any hearing loss, in Brazil and abroad; Telematic Newspaper - the creation of a newspaper containing texts of the deafs' daily lives; Story Book - an interactive story book containing collaborative stories written by our group of students and by students with special educational needs from Portugal. One of the students would write the beginning of the story (a brazilian or a portuguese student) and another friend would write the end of the same story.

Thus, support linguistic strategies related to aspects such as expression and content were used.

As summary we can point out improvements in some aspects.

In the *linguistic domain*, for example, the students:

(1)attained a satisfactory level of written expression since they were able to produce more coherent and cohesive texts;

(2)demonstrated more practical knowledge about phrase structure, which involves: adequate elements' order; verbal time; adverbial pronouns; verb and noun concordance; use of prepositions ; correct punctation.

In the *cognitive* perspective the students:

(1) presented improvements in their interpersonal relations, interchanging information and personal experiences;

(2) were able to express feelings and sensations, through writing; presented higher levels of autonomy, initiative and self-confidence.

In the *socio-affective* dimension and related to the cognitive aspects mentioned above, the students:

(1) attained higher levels of comprehension of the written messages ;

(2) were able to interpret the ideas expressed in the texts;

(3) were able to see other points of view besides their own;

(4) were able to identify errors and tried to correct them;

(5) made more associations, inferences and antecipations

What we here present is a very brief summary of the development of the deaf individuals whom we worked with. As we mentioned before, the focus of our observations was the interaction/communication process in a telematic environment and its possibilities to contribute in the deafs' development in the specified dimensions.

Over all, our observations suggest the importance to construct communication/expression interactive means and situations which may promote cognitive and social-affective dimensions for this special population.

We work towards minimizing the existing discrimination of this population, which is still very strong in our society, perhaps more in the so called third world countries. We also try to create and think of alternatives which can be carried out in "virtual schools and virtual classrooms", which can offer interactive opportunities with other people and access to information through "windows to the world" and aiming to enhance self-education.

Technology Integration in Collaborative Writing

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This study of technology integration in collaborative writing took place in a required sophomore course called Business Communications. Weston and McCloud, the two instructors who re-designed and implemented this course, had corporate work experience to compliment their 17 years as university lecturers. Their re-designed course stressed a business-like environment and set the expectation that student generated business writing would be at a level acceptable in an authentic corporate environment. Students were treated as adults and expected to be responsible, self-directed learners. They worked in collaborative teams and utilized the available computer technology to produce written responses to problem situations. The four classes (fifty students each) met every Monday and Wednesday for 75 minutes in two connected computer labs. Each lab had twenty-five networked PCs, a laser printer, comfortable office chairs, and the usual florescent lights, utility carpet and neutral colors. The use of technology to support collaborative writing was part of a learning environment that included an extensive instructional simulation, collaborative teams, team teaching, and problem/project based learning activities.

Instructional Simulation - An instructional simulation of a multinational corporation (Starr Corporation) organized the course, provided a realistic business atmosphere and a context for the writing projects. Students were "hired" into the corporation and received an Employee Handbook with detailed information about the corporation and also served as the course syllabus. To ensure that all students began with a basic knowledge of word processing, spreadsheets, a graphics program, e-mail, and Internet browsers, the new employees were provided with training sessions (intensive workshops) on these business applications. Students were assigned to teams by the teachers, and teams rotated through a variety of departments within the organization to learn about various aspects of the corporation including; Marketing, Accounting, Purchasing, Human Resources and Operations. In each department, the teams received information related to the functions of the specific department and were tasked with producing an appropriate written response to the problem situations being presented. These assignments addressed the four primary types of business communications: routine, good news, bad news and persuasive letters or memos in the context of each department. From a theoretical perspective, the Starr Corporation simulation provided a larger context for the writing assignments (Honebein, Duffy, & Fishman, 1993; Savery & Duffy, 1995) that made the learning activities more authentic and meaningful for the students. From a technology perspective, all assignments were designed with the expectation that the computer technology would be utilized as a productivity tool.

Collaborative teams - The teachers assigned individuals to teams that were balanced along several key criteria - gender, part-time work responsibilities, prior business experience, leadership abilities, computer expertise, and several secondary criteria. (Kagan, 1992) Teams typically consisted of five (5) members that remained together for the semester. Individual students shared the grade for all team assignments such that 60% of an individual's grade was obtained through teamwork. This shared grading strategy was an important design component as it promoted a high degree of goal interdependence and resource interdependence (Johnson & Johnson, 1990) and produced many examples of mutual support, peer tutoring and team members holding each other accountable for incomplete tasks, tardiness, and missed classes.

Team Teaching - Neither teacher lectured during class sessions choosing instead to coach and mentor individuals and teams. Both acted as tutors and provided context (problem) specific coaching and extensive modeling of the metacognitive processes used by experienced writers. The teachers were generally able to provide individual students with the amount of cognitive scaffolding required as they developed their individual abilities and moved to teacher-independent behaviors.

Problem/Project based approach - Teams had four class sessions in which to produce written responses to the problem situations. Student teams became proficient at assigning tasks, coordinating efforts and completing the project within the time specified: project management skills seen as beneficial learning outcomes that complimented learning the core content of effective business writing. The project based approach allowed teams to improve from one project to the next by incorporating teacher feedback, comments and grades. The use of realistic problem scenarios encouraged students to go beyond the information provided (see Bruner, 1973; Perkins, 1993) and utilize their higher-order thinking skills. (Barrows, 1992; Barrows & Myers, 1993) The writing assignments required students to extend their skills and knowledge with computer applications, e.g. Accounting required the team to prepare a Payroll Report (spreadsheet) for the entire class, Marketing, required the team to prepare a multi-column promotional brochure that included graphics.

Integration of Technology with Collaborative Writing - Collaborative writing as described by Saunders (1989) contains a range of interaction structures that combined with the tasks assigned produced four primary categories of collaborative writing activities: co-writing (most collaborative form), co-publishing, co-responding and co-editing (least collaborative form). All four teams in this study used the co-editing format consistently with isolated examples of co-writing. Co-responding was the dominant form of collaborative writing for assignments in departments other than Operations. Students did not share ownership for the texts they planned and composed individually, but they did help each other with the review process. Several teams shared resources electronically, organized members via email during the planning and developing stages, and used advanced features of the word processor (i.e. table of contents, embedded graphics, running heads, etc.) to produce professional looking documents.

Summary - All classes were held in the computer labs reserved for the course, enabling students to work with a consistent set of tools-word processor, spreadsheet, graphics, and web browser. By providing skills based training up front, and ensuring that expertise was available on each team, the teachers were able to require the use of the technology and focus on designing writing scenarios that were challenging and realistic. Students shared their knowledge and skills with different applications with their teammates for the benefit of the shared grade. The structure of the learning activities promoted the development of situation specific skills i.e. create a two column letter, or insert a graphic. Over the semester these situation specific skills were repeated and shared with teammates resulting in greater mastery and learning of the skill. By the end of the course the majority of students were comfortable with most aspects of the technology used in the course. Some students became expert with specific applications and others developed a core set of skills and competencies in all applications. More importantly, all students were able to use the technology to work together in collaboration to generate business correspondence.

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Towards the Integration of Student Support Sytems Via the Internet

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Abstract: There is much more to a successful education system than the quality of the academic experience. How the educational environment supports a student is a key to that student's academic success and personal development. In this paper we discuss how we are attempting to move current stand-alone pc student guidance and support multimedia projects to the internet. In addition, we discuss how we are working on bringing our own projects together with other's work on database and information systems into a common and interdependent framework. For simple multimedia projects such as these, the move to the internet is both easy and compelling.

What guidance do students need?

Guidance and support for students is needed at every stage in a student's career: at entry; during study; between courses and at the end of a study programme. In an ideal educational environment the student should be seen as a whole person whose learning takes place in the context of past experiences, present circumstances and future hopes and aspirations. The UK Open University was founded on a multi-media approach combining initially print, television, radio and audio cassettes, face to face tuition and academic counselling, telephone communications and correspondance tuition to teach and support students. These 'traditional' media have been joined by video, and more recently by computer media such as CDROM, computer mediated conferencing, electronic mail, and now the Internet. We show that the move of simple forms of student support to the internet can be both compelling and straightforward.

Eg : UKOU Support Services for Students

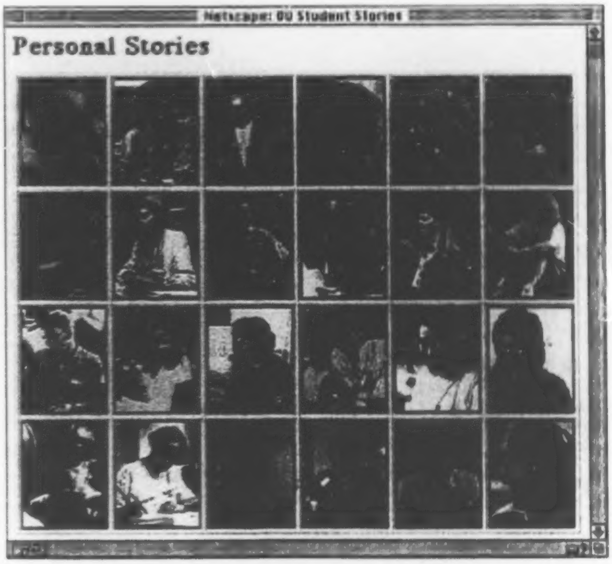

Figure: 5 An OU Support Services for Students Web page.

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The Support Services for Students system was produced by the Regional Counsellors and Tutors and Academic Computer Services at the Open University using Macromedia's Director™. This system was converted to a html+RealAudio™ version very rapidly. The system aims to inform current and prospective students about the facilites offered by the UKOU and to provide a perspective on studying with the OU from a variety of different angles. The core of the system are stories told by OU students about how the issues affect them. In the figure [Fig. 1] from the experimental web version of the support services for students project - the student is invited to hear the personal stories of a number of UKOU students. Each story raises a number of issues which are then explored further within the system. Each individual screen consists of text and graphics with appropriate links to other pages - as in any hypertext, [Fig. 2].

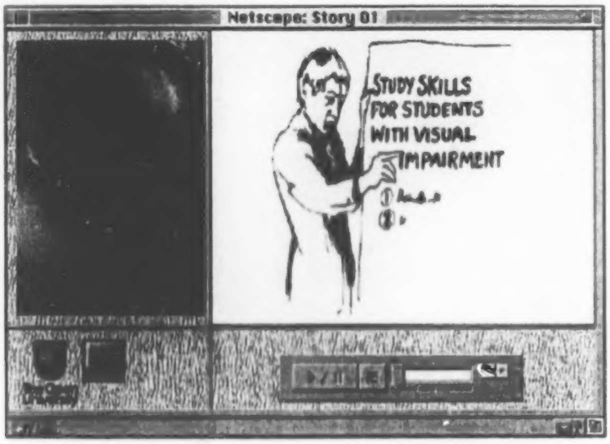

Figure 2: An SSfS Student Story with RealAudio.

Bringing CD Multimedia to the Internet to support students

There are many well aired issues in the contest between network delivered services and stand alone services.

Disadvantages

- The quality of the final product is invariably less - as one makes design compromises to suit students with slower connections. This is particularly true in an open learning context where adults are learning in their own homes, paying their own telephone/connection charges. It is still very difficult to deliver projects that require good quality video due to limitations in bandwidth and compression.

Advantages

- The project is instantly accessible from anywhere with network access. Anyone with a suitable pc and modem can now access these systems. They do not have to find out about the availability of the system and wait for the CD to come to them - as soon as they know about the system they can come to it!
- It is very easy log usage. Whilst one can count the number of CDs that are put in the post out to students but not the use that is made of them after they enter the postal system - and feedback is hard to collect from students - who have to go out of their way to return a questionnaire. However, every access to every page of the server of the web versions can be logged, and feedback is so easy for the student to give via email links on pages, that it is hard to stop users telling you what they think about the system, even before it is properly released! At the moment these systems are still experimental and we have no formal usage data - but we hope in due course to report on the network evaluation of the systems.
- Integration with other major network resources. From the students point-of-view the distinction between the distinct but related projects such as these two becomes significantly less. We are now working on integrating a number of complimentary systems into this simple framework.

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Collaboration and Negotiation through the Learning Web

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Abstract: The *learning web* approach can be effective in supporting collaborative learning involving major groups of students operating as goal-directed, structured teams. It is natural for such teams to use hypermedia technology to record their own group processes in achieving their goals, particularly if communication with another team is an intrinsic part of their task. This article shows how an effective learning web can be established through a situation in which students play roles in customer and supplier teams concerned with a system development task. The only technologies used are commonly available web servers, browsers and text editors.

Summary

Learning web methodologies may be applied to existing courses in order to facilitate collaborative and self-directed learning and break out of the traditional lecture and classroom format (Norrie and Gaines, 1995; Gaines, Norrie and Shaw, 1996; Shaw and Gaines, 1996). CPSC451, a required software engineering course for Computer Science majors, is centered on projects that involve the students playing roles in teams representing customer and supplier organizations. Each student is assigned to two different groups of 10 to 12 students. In one group she is one of the supplier team, and in the other one of the customer team for a different project.

It has been natural to use the learning web in CPSC451 to support the group collaboration and the customer-supplier negotiations which in previous years were communicated only through documents. All the course materials are already made available to the students through the web, and it is a simple extension for students to place the documents relating to customer requirements, supplier comments and proposed solutions, the ensuing negotiations, and descriptions and screen dumps of the developed applications on the web. The notes below were given to students on how to use web facilities in a simple and natural way to manage their projects.

Using the Web for Requirements Tracking

The World Wide Web supports the sharing of structured multimedia documents with links to one another and to other material, not necessarily in HTML format. This makes it a suitable base technology on which to develop a requirements tracking system for software engineering that tracks the relationship between requirements, analysis, design, implementation, application and maintenance.

For CPSC451 we will use the web to develop a set of linked documents tracking the customer group requirements specification, the negotiation with the supplier group to clarify them, the design specification, the customer commentary on this, the implementation, acceptance procedures, and so on.

Rather than use special-purpose servers we will take advantage of the web's capability to link documents held in different locations, and generate a sequence of documents held in the directories of those in the customer and supplier groups. A single master index managed by someone in one of these groups will be used to make the distributed set of documents available to everyone in the groups.

Linking and Annotating Material

By putting all the customer and supplier documentation in the web directories of members of the customer and supplier teams it automatically becomes available to everyone. However, it is not linked together and it may not be obvious how the documents relate to one another. Two things can be done to improve the situation.

First, someone in the customer group should agree to become documentation manager for the entire project and maintain an index in their web directory of all the documentation from both customers and suppliers. This index will contain pointers to the distributed set of documents allowing them all to be accessed from one place. Anyone needing to look at the project documents will start with the index and click on a document in it to fetch that document. Anyone generating a new document that should be entered in the index should email its url to the documentation manager specifying where it belong in the index.

Second, while you cannot edit a document in someone else's account, you can fetch it with a web browser, save its source, annotate that source with your comments, and make the annotated document available in your account. Thus, the index will grow to be a sequence or a tree of documents such as a customer specification, a version annotated by the suppliers with queries about the specification, a version of this annotated by the customers with answers to queries, and so on. Similarly, an initial design specification from the suppliers can be annotated by customers.

Style of Annotation in HTML

You will need to establish some style guidelines for documents so that you can distinguish annotations from the original. One good technique is to use a horizontal rule before and after annotation. Tags for bold and italic can be used to mark particular sections of text to which you are making reference. There is no obvious or standard way of doing this. Experiment with HTML and decide on an approach for your group (but don't spend more time on an annotation scheme than you do on the actual software engineering project!).

What Should be Documented on the Web

Any documents that you can generate on paper you can also put up on the web, so that your project web should finally provide a complete account of all the activities of the project. For example, you can link to design material that includes screen-dumps as GIF images. In a real-world project that used the web itself to implement a client-server system you would even be able to link to the working system so that the requirements and design information was available for maintenance and enhancement support. If your implementation is on the departmental unix system then you should be able to provide a link that starts a live demonstration.

Conclusions

In the first paper on the learning web we argued that, given appropriate initial conditions, groups forming learning webs would organize themselves in a robust fashion to achieve their learning objectives. The experience with CPSC451 and other courses has shown this prediction to be correct. With the appropriate definition of the social dynamics, specification of the objectives, motivation of the participants and provision of supporting technology, the learning web approach is very effective in promoting collaborative learning.

The supporting technology is very simple and already widely available to educational institutions. CPSC451 used only standard web servers, browsers and text editors. No special-purpose tools were used. The students were third year computer scientists and hence had familiarity with computer use and text editors, but most had no prior experience in the use of the World Wide Web. We have found in other courses with students across a range of non-computing disciplines that the capability to prepare documents for the web is easily acquired in a few hours experience. The approach described in this paper can be used in any discipline.

The web created by CPSC451 students in 1996 is part of the learning environment supplied to CPSC451 students in 1997. Thus collaborative learning is being encouraged not only within cooperative groups, and across negotiating groups, but also longitudinally between classes in different years. The students who are learners in one year know that they are also teachers for the next, and hence can take pride in knowing that their achievements will be of value to others, not just exercises for the instructor to assess and then forget.

CPSC451 is an important course for students seeking employment in industry, since most potential employers see computer science students as lacking in the group collaborative skills that CPSC451 develops. The archiving of the materials on the web automatically creates a "portfolio" for each student through which they may show to a potential employer that they have had experience both in specifying requirements for others and in developing systems through teams that have negotiated requirements with others.

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The Effect of Type of Courseware on the Achievement of College Students Enrolled in a College Algebra Course toward Problem Solving

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Abstract: This study assessed the problem solving ability of College Algebra students using a variety of instructional software. A computer algebra system, a teacher written hypermedia program, a graphing calculator, and the combination of both the computer algebra system and the hypermedia program were used to teach and to solve distance and mixture problems. Post-test results showed significant differences between the groups. Students using the hypermedia program or the combination of both the hypermedia program and the computer algebra system scored significantly higher than the control group, the graphing calculator group, and the computer algebra system group on all problems and also the problems that tested for near transfer of problem solving skills.

Objectives

This presentation will show the differences in the effect between a hypermedia program, a computer algebra system, a graphing calculator, and the combination of a hypermedia program with a computer algebra system on college students' problem-solving ability in a College Algebra course. Further, this study will show if the type of courseware has an effect on near and far transfer of problem solving skills.

Perspectives

With the introduction of Computer Algebra Systems and Hypermedia Assisted Instruction, the choices for type of courseware are more diverse. [Palmiter, 1991] demonstrated that knowledge of calculus concepts for students using *Macsyma*, a computer algebra system, was significantly higher than for students taught using traditional instruction. Hypermedia programs can be designed to incorporate anchored instruction by allowing the user to navigate to different areas of the program to gather and use information. The amount of time required to teach the basic algebraic manipulations has reduced the attention teachers can allot to problem solving [Campione, Brown, & Connell, 1989]. As a result of the lack of time on problem solving skills, students are unable to develop the repertoire of strategies needed to solve word problems.

Sample

The sample consisted of five groups of students enrolled in College Algebra. All five groups had the same lecture time The control group, was not exposed to any computer instruction and only had the use of a scientific calculator. The second group was allowed the use of only a graphing calculator (*TI 85*). The third group was only permitted the use of a computer algebra system (*Derive*). The fourth group used hypermedia instruction, but was not allowed the use of *Derive* or the *TI 85*. The fifth group was allowed the use of hypermedia instruction and *Derive*.

Background

The *TI 85* calculator has a solver function built into the calculator that can solve linear and quadratic equations. *Derive* is a computer algebra system that will run on most personal computers (386 or higher). Because it is menu driven, *Derive* is easy to use. The purpose for *Derive* or the *TI 85* calculator in this experiment is solving the messy linear equations that are formulated from rate problems. *Mathquest* is a hypermedia program written by the researcher with the use of *Authorware*. The instruction of rate problems is anchored in two investigative games; one involving mixtures and the other involving distance and speed. *Mathquest* also has practice problems and tutorials on solving rate problems and incorporates sound, graphics and animation. *Mathquest* was designed within the context of anchored instruction.

Results

Since the ANOVA showed no significant difference in pre-test scores, a one-way ANOVA was used on the post-test scores. The results showed significant differences between some of the groups $F[4,75] = 6.076$, $p < .0005$. Upon further analysis, it was found that both of the groups that used hypermedia scored significantly higher than the groups that did not use hypermedia. The group that used hypermedia alone scored significantly higher than the control group (p value $< .1$), the *TI 85* group (p value $< .1$), and the *Derive* group (p value $< .1$). The group that used both hypermedia and *Derive* scored significantly higher than the control group (p value $< .005$), the *TI 85* group (p value $< .005$), and the *Derive* group (p value $< .005$). There were no significant differences between the control group, the *Derive* group, or the *TI 85* group.

Since the ANOVA showed no significant difference in pre-test scores for the near transfer problems, a one-way ANOVA was used on the post-test near transfer problems. The results showed significant differences between some of the groups $F[4,75] = 2.742$, $p < .05$. Upon further analysis, it was found that all four groups that used any type of courseware scored significantly higher than the control group (*TI 85* significantly higher than control, $p < .05$; *Derive* significantly higher than control, $p < .05$; Hypermedia significantly higher than control, $p < .1$; and the hypermedia and *Derive* group significantly higher than control, $p < .0005$). Also, the hypermedia and *Derive* group scored significantly higher than the *TI 85* group and the *Derive* group, $p < .05$. The ANOVA for post-test far transfer showed no significant differences between the groups.

Implications

The results show that the use of teacher generated hypermedia programs can cause significant increases in student ability toward problem solving. Anchored instruction may be the reason the hypermedia groups scored significantly higher than the other groups. In order for there to be a problem, someone must want to solve it. Without motivation for solving problems, students will not try as hard to solve problems. Using a graphing calculator or a computer algebra system allows students more time to set up more problems and become better problem solvers. However, a graphing calculator or a computer algebra system does not give the student motivation for wanting to solve the word problems. With hypermedia programs students have more of a motivation to solve the problems, because the problems can be anchored in a real life situation or game.

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110Tech: Digitizing Humanities at Reed College

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Abstract: What can professors do better with computers than without them? Should faculty be encouraged to learn HTML authoring, and if so how? What characterizes the most valuable electronic course materials? How do e-mail lists best enhance a small class? How is data projection used most effectively for large lectures? The paper offers some answers through a look at the challenges involved with introducing an electronic component to a large freshman core course on antiquity taught simultaneously by twenty-two professors. It includes statistical analysis of student opinion polls conducted after a trial period; responses of students in technologically enhanced pilot groups are compared with the rest.

How do you take a freshman core Humanities course on ancient Greece, Rome, Judaism, and Christianity, team-taught by twenty-two different professors at the same time, a course taught more or less the same way for the last fifty years, and enhance it through the use of information technology? As recently as 1993, Reed College's Humanities 110 course, the only course in the entire college curriculum required of all matriculating students, had no technological component at all. Today it integrates electronic information in a number of different ways, and it provides a test case on helping faculty who have never taught with technology to do so.

At first we had some doubts about the wisdom of training the faculty members in the authoring of web pages. Although the learning curve was fairly steep, a consensus has emerged that this particular skill is worth mastering. It provides faculty with a powerful new tool for communicating information to students and putting them in touch with the resources which enable them to progress towards becoming independent researchers. We expect several different factors to push us further in the direction of training faculty to create web pages in the near future. First, the automated conversion of word processing documents will improve. Second, the prejudice of the scholarly community against electronic publication and in favor of print publication will decrease, giving faculty members more incentive to learn how to publish their work on the Internet.

The web pages created as a result of the 110Tech project are certainly not spectacular from a technological point of view, but they serve their purposes. One such purpose is simply archival. Before 110Tech, a limited archive was maintained for the course in the form of a shared folder on one of the campus servers. However, this folder contained only those documents which were generated by the secretary of the course: the syllabus and the paper topics. All of its documents were in a single format (Microsoft Word for Macintosh). Few students and faculty seemed even to be aware of its existence, and it was inaccessible to anyone not connected to the campus network, including students and faculty connected to the campus' computers by modem. Even PPP, which Reed began supporting in 1995, was of no help for this purpose as our PPP server does not support Apple Remote Access. The 110Tech project energized and extended an effort already under way to increase dramatically the number and range of course materials available in the archive by using web pages, and can claim this as a success. We now encourage members of the faculty to submit electronic copies of their handouts to the course's secretary, who converts them to HTML and links them to the course page. 110Tech faculty also pioneered the practice of posting complete texts of entire lectures on the course page, and this caught on nicely: five lecturers other than the 110Tech pilot members have posted entire lectures. Nor has there been any discernible decline in attendance at the lectures of those who do make complete texts available. This new archive takes advantage of the natural cross-platform quality of the web, making it a marked improvement over the old method, insofar as it is accessible to students who are not on the campus as well as to students who are using PC's or UNIX machines. See http://web.reed.edu/academic/departments/Humanities/Hum110/.

In addition to the course archive, the 110Tech faculty created a separate set of pages which focus on particular topics (e.g. the Afrocentric approach to ancient Greek history). These aim to introduce users to scholarly debates about central issues, and at the same time to point them to resources on the Internet for further research. Although these pages have no formal role in the course, they have been used to spark class

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discussions and as the basis for papers. They are also the biggest draw for people visiting from off campus. For these pages see http://homer.reed.edu/.

A major limitation on what the project could hope to do emerged as we weighed it against the mission of the college. Like many another small private liberal arts college, Reed makes little pretense to being a resource for the community at large, beyond welcoming the public to its library, exhibits, certain lectures, and so forth. The educational resources of the college, especially the time and attention of the faculty, are intended primarily for the benefit of its own students. This makes sense at one level. In an increasingly competitive market for students' educational dollars, the personal attention of the faculty and the sense of a small community are ways to set such a college apart from the much less expensive state universities. The more we experimented with electronic distribution of course materials and class discussions in virtual space, the more it became apparent that the technology could permit us to offer the course to a wider audience, including students not enrolled at the college. But we encountered strongly negative reactions from the administration to any suggestions that the college might move in the direction of offering courses wholly or mostly conducted in virtual space. Hostility to the distance learning model was marked. As one technologically savvy senior member of the faculty put it, "We are not some kind of community college."

Humanities 110 is unusual, but not unique, in the way it uses faculty resources. The staff includes some people who have been teaching the course for twenty years and others who are teaching it for the first time. Those with less experience tend to follow the syllabus and other recommendations of the entire staff, such as for paper topics, very closely. At the other extreme, some of the veterans have long established techniques which work for them, and their version of the course freely deviates from the standard line. Because the structure is collegial, it is impossible to impose mandates about how the course is taught. Nor would that necessarily be desirable. The 110Tech faculty, confronted by our inability to legislate from above, has chosen instead to try to lead by example. Progress from this method is slow but sure. We built our web sites, packed them full of useful content related to the subject areas of the course, publicized their existence gently, and waited for our colleagues to say, "I should be doing this too." At this writing, five members of the staff in addition to the original five pilot conference leaders have voluntarily begun to learn HTML authoring and experiment with technologically enhanced conferences. The number should rise as a result our summer workshop for faculty, which will provide $500 mini-grants drawn from our Mellon funds as an incentive.

We conducted a short, anonymous multiple-choice survey of those students who came to the lecture on 1/31/97. The results (tabulated in the electronic version of this paper) were informative. The 110Tech students were significantly more likely to have accessed the Internet sites more frequently: 53.2% of them reported using the sites five or more times as against 31.2% of the regular conferences. However, a core of around 19% of students in both types of conference said they had never seen the pages at all outside of the classroom. This suggests that some better means of demystifying the process of getting to the electronic course components needs to be found for those students not comfortable using the technology. 110Tech students were slightly more likely than the rest to report finding the pages very useful (40.7% as against 33.1). Only a small percentage of students reported that they had seen the pages and found them not at all useful (4.6% overall). The students in the pilot conferences were also significantly more likely to have exchanged frequent e-mail with their instructors. 31.3% reported exchanging e-mail five or more times as against 23% of students in ordinary conferences. Fewer 110Tech students said that they had never exchanged e-mail with their instructors (25% as opposed to 34.8%). The latter figures remain surprisingly high for both groups. It suggests that the College could do more to publicize and promote the use of e-mail lists of the kind that permit a student easily to send a message simultaneously to her instructor and all of the other members of the conference.

The 110Tech faculty has also tried using data projection for the large lectures, with mixed results. Our early attempts at using data projection in the lectures were fairly clumsy. This came through in the survey. Although a majority of students said that the lectures were improved by the data projection (57.9% overall), an informal response to the survey by faculty in the weekly staff meeting had 7 of 8 respondents stating that the data projection detracted from the overall effectiveness of the lectures. A significant minority of students (9.3% of those in ordinary conferences) agreed. Most recently in the spring semester of 1997, more effective use of the data projection has been made. An informal consensus has emerged to the effect that what works best is to have the screen blank for most of the lecture, with a discrete block of time set aside for the projection of and commenting on digitized images. For text-based lectures which make no use of images, data projection appears to provide no significant advantages, and in some cases is merely a distraction.

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Developing Multimedia for Educational Purposes

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Abstract: The aim of this study was to explore the practicality of constructing effective educational multimedia courseware within the secondary school context. Many institutional constraints appear to militate against schools devising and constructing even comparatively modest multimedia resources, tailored to the needs of their own pupils and syllabi. Two quite different projects were undertaken: one, a comparatively modest interactive presentation to supplement academic tuition in two or three major curriculum areas; the other, an interactive instructional program required to teach concepts as preparation for practical classwork. A *Why?—What?—How?* requirements scenario was employed to advise and guide the young designers. Both project teams succeeded in creating a logical and coherent structure, incorporating non-sequential as well as linear navigation possibilities. The systems were designed through the use of iterative prototyping and then the usability of each system was assessed before proceeding to full development and implementation. With everyone's sights constantly set on the target end users, it was a surprise to discover that those who learned most were, in fact, the younger members of the project teams: of necessity, theirs had been a thoroughly effective and detailed engagement. There were other advantages too: the approach encouraged flexibility of teaching methods: broad-ranging, non-traditional, cross-curricular collaboration and resource sharing; and 'in-house' easily accessible target user population imparted a strength to the design of the system. As a result of this project there was general consensus that we had just begun to glimpse the potential of multimedia technology for developing new study skills (while reinforcing existing skills), in a pupil-enticing environment.

Introduction

Given that previous research has shown that effective multimedia assists learning, the original problem was : would an interactive digital storage program delivering text, still and moving images, and sound (ie. multimedia technology) be a realistic proposition for development by teenagers in schools?

CBL literature widely assumes construction of learner-centred instructional multimedia courseware but nowhere appears to address the present impracticality of such activity in the secondary school context. It is no solution simply to place such technology as multimedia at the disposal of any subject teacher wishing to develop courseware: good hardware/software is too expensive for exclusive departmental use, and multimedia merges disciplines which, historically, have developed in some isolation.

Requirements Analysis

Initially questionnaires were issued to the staff to try to uncover the technology being used within schools and and it was discovered that a range of commercial multimedia was in occasional use, for revising or supplementing classroom tuition. However teachers disliked the fact that the material was often too wide and general for their purposes, but favoured the good technical quality and convenient integration in one place of a variety of media resources.

Two curriculum areas were identified, one combining a wide variety of media resources to supplement traditional classroom teaching, the other delivering conceptual and technical training in preparation for subsequent practical work in the classroom. The former (geography) was keen on centralising resource materials for a local study concerning the Giant's Causeway in County Antrim, Northern Ireland. The second project proposal arose from a pedagogical need within the Media Education department:

Initial design

From the functionality requirements analysis, a description was devised of actions required from users and, from the task analysis, how the user would perform an action to accomplish a task. Tests were then written for each instructional objective with practice interactions then devised for each test item. Nextly usability testing with the target users identified an acceptable level of performance and iterative testing of prototype samples helped to identify whether the design suceeds in fulfilling the requirements.

Prototyping

Limited but practical working models for each project were produced and tested. Observation of a representative, small number of users was conducted to validate client/user-expectations and to assess how far users would understand content and operation. The extent of iteration was determined by user acceptability. The Causeway prototype tested the main menu, preliminary screens for each topic and their full selection of visual and aural transition effects and media component types. The software - 'Astound' - allowed information to be directly entered on the screen slide: automatic programming of the computer was achieved by the software writing corresponding lines of computer code. However, the Video project team had some scripting experience in HyperCard and were able to implement a greater degree of interactivity and computer dialogue to motivate user engagement. User-attitudinal considerations dictated that system dialogue should always be made relevant, clear and concise, and that any error messages should be supportive and non-challenging.

Implementation tools

Pupils involved in the Causeway project had no previous experience of working with multimedia software. Gold Disk's 'Astound' software provided an easy-to-use tool, appropriate for constructing the type of presentation required by both client and users. The main window allowed pupils to create, edit and preview each slide by accessing convenient menus, tools and icons. The Video project required some variety of input by users governed the choice of HyperCard software. Its HyperTalk programming language (userlevel 5) is very accessible to secondary school pupils and use is not dependent on experience or aptitude for programming.

Reflection & Evaluation

Building multimedia courseware within the secondary school environment can result in much more than the creation of an artefact. The general aim of the projects represented in this study was to devise and construct a computerised system offering dynamic representation: textual, auditory and visual learning. The majority of the electronic media materials were custom generated by the pupils forming the project teams. These young people experienced a sense of personal responsibility for the success of a wide variety of educational activities: research (print/visual/audio texts); drafting/evaluating/redrafting in a variety of media; collaborating in groups of varying sizes, across curriculum subjects; purposeful discussion; using a variety of technologies; producing programs for specific user audiences. As well as the courseware being largely successful in achieving the set goals, the primary benefits of such work are for those producing the material.

The importance of the teacher as a subject and method expert can be significantly reduced by CBT. However, developing educational multimedia as above poses little risk to teachers becoming little more than 'general facilitators.' The burden of repetitive lecturing is lifted. Interpersonal skills become more significant, allowing teachers to develop better and more individual relationships with pupils. Understanding the learning process as well as the new technology becomes important. Careful management, with the full commitment and enthusiasm of teaching staff, greatly facilitated non-traditional and cross-curricular innovatory teaching methods during the current study.

Future development

For schools, the implications of such new technological communication as interactive and instructional multimedia are great. The secondary school curriculum contains a great diversity of topics for self-access interactive learning material targeted to the needs of specific learners. Producers of such material should experience and enjoy the development of new study skills and reinforcement of existing skills in new contexts. The projects involved in the present study necessarily employed only low-end multimedia tools. As a starting point, such software enables novice pupils to construct programs quite quickly and with some comparative success. From such experience, it is planned that they will progress to more complex projects employing more sophisticated, high-end multimedia software, such as Macromedia Director or Asymetrix Toolbook.

Inter and Intra Courseware Structure for the Inter-operability of CAI Programs

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Abstract : Most of CAI programs are developed by authoring tools are not inter-operable and the non inter-operability hurts the diversity of course works and reduces students' desire on knowledge. To resolve this problem, this paper proposes a way to develop CAI programs through Inter courseware structure and Intra courseware structure. Intra structure is a structure that allows to develop an independent CAI program with combinations of various educational multimedia objects. Inter structure produces a synergistic effect that can not be expected in a single CAI program, by allowing the inter-operations among the pre-made CAI programs.

I. CAI Programs Based on Intra and Inter Courseware Structure

We model a CAI program as a software that is constructed with three appropriately combined elements. The elements are teacher element, student element, and content element. The teacher element implies how to teach students with what kind of contents, such as the aim and the content of course work, teaching strategy, and feedback strategy. The student element is the behavior type of student, the level of student, and the interactions between students and CAI programs. The content element is various educational multimedia objects used for explaining the content of course works efficiently.

For example, consider a CAI program that, to teach an add operation with two one-digit integer numbers, after representing each number as an apple, asks students the result as a number and then, shows the feedback. In this case, numbers from 0 to 9, apples, sound or graphics for correct answers are considered as the educational multimedia objects. Inputting correct answers with keyboard and the level of student are the student elements. To try to make the student understand add operation by showing graphics for add processes is a teacher element. Depending on how these three elements are combined, various CAI programs can be generated.

The Intra courseware is an infra structure that allows to build CAI programs by interconnecting dynamically the above three elements stored in the database. Since it is possible to reallocate dynamically the internal resources such as data and program code demanded by users while operating the coursewares developed following this structure, they can implement more functions than in the traditional CAI programs and allows to re-use the resources for other CAI programs. For an instance, all resources such as numbers, apples, graphics and sound used in the above add operation CAI program can be re-used for other CAI programs.

It is not recommendable to make new CAI programs for every coursework, though it is easy to edit various CAI programs re-utilizing resources with the help of intra courseware structure. It is possible to produce a new educational effect by using a part of the functions contained in pre-made CAI programs. Especially, it is very hard to analyze the possible behaviors of students in advance and apply them to editing CAI programs. Instead, by co-operating independent CAI programs, a synergistic effect may be obtained. For this purpose, this paper proposes "Inter courseware structure". The inter courseware is an inter-operation and inter-communication model between the coursewares developed for different purposes. In the Inter courseware structure, the possibility to share resources among CAI programs and to re-use CAI programs increases.

II. Implementation issue and future work

We have implemented SAEBIT to realize the Intra courseware concept [Jung and et al 1995]. SAEBIT supports the functions associated with constructing new CAI program units combining frames or OEM (Operable Educational Multimedia) with the pre-mentioned three elements. The frames are stored and managed in the

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OEMDB (Operable Educational Multimedia Data Base). New OEM objects are made with the combinations of three elements. It is possible to realize a new CAI program by re-ordering the pre-constructed OEM objects. To make combining the OEM objects easier, "Logic objects" are introduced.

Figure 1 shows three examples of constructing CAI programs by SAEBIT. They utilize five same OEM objects. But the constructing strategies they hire are "Programmed Control", "Loop", and "Learner Control", respectively. The OEM objects in figure 1 are represented as five icon's : *start, ending, content, feedback1, and fedback2* while seven icon's, *branch, cond1, cond2, loop, interact, select1, select2* are logic objects. Figure 1.1 shows that the five OEM objects are interconnected with each other by logic object branch that decides the next displaying frame according to students' input. In figure 1.2, the five OEM objects are interconnected with each other by a logic object, loop for a repeated lesson. In figure 1.3, based on the learner control strategy, the five OEM objects are interconnected by three logic objects : interact, select1, and select2.

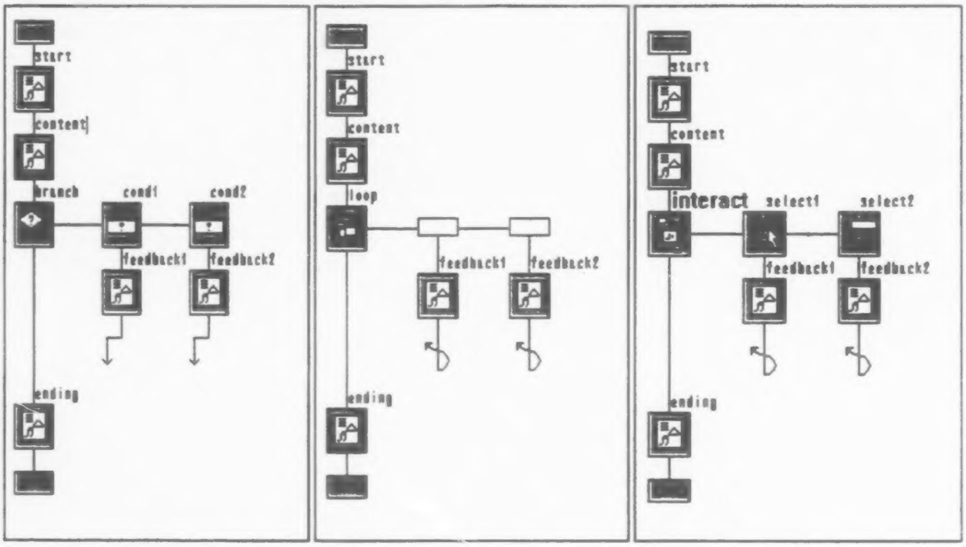

Figure 1.1 Programmed Control   Figure 1.2 Loop   Figure 1.3 Learner Control

Figure 1 : Examples of Inter courseware implemented by SAEBIT

For a CAI program to have an independent function and to co-operate with other CAI programs successfully, it requires a communication structure to interconnect CAI programs, and an appropriate communication handling process. With the communication capability, the CAI program can support the demands from students who are using other CAI programs. The way that some functions of a CAI program can be provided to other CAI programs is similar to using URL in Internet to navigate Hypertext, in terms of the functionalities. But in terms of the access unit, it requires a finer granularity than Internet does. This implies that when a CAI program tries to use a function supported by other CAI program during its execution, it is desirable to execute the requested CAI program partially rather than execute the whole program.

This paper proposes a way for a CAI program to handle the messages requested by other programs to allow co-operations among the programs. The messages are handled by a special sequencer and the handling routine is similar to that for the reactions during execution of learning process. It is close to a dynamic DFD (Data Flow Diagram) that several CAI programs are being inter-operated.

It is expected to improve significantly the utilization of CAI programs made by teachers, once the Inter courseware function (currently being upgraded) is added.

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Issues in The Development of Computer User Interfaces for Disadvantaged Multicultural Communities

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Abstract: The design of computer user interfaces for disadvantaged multicultural groups presents a challenge to interface designers. This paper examines some of the key psychological aspects such as social class, locus of control, role of the sexes, age and language that could possibly influence the human-computer encounter of such groups. The results of a study done on two groups of students from multicultural backgrounds to determine differences due to cultural factors when using simple text based interfaces in simulated and real-life situations are discussed.

Recent political change in South Africa has caused major changes in the educational structure. Not only was the entry of previously disadvantaged groups into the higher levels of education greatly increased, but the process of affirmative action placed many previously disadvantaged workers in positions where they need to use computers. As a high percentage of these students has never been exposed to technology or even electricity, working with a relatively sophisticated instrument like a computer involves a major paradigm shift for the student. The multicultural nature of the South African population, low literacy levels [Hartshorne 1996] and extreme poles of social development pose a unique challenge to interface design. This paper discusses some of the cultural issues that could influence the human-computer encounter in a disadvantaged multicultural community. The results of ongoing research to determine cultural differences when using computer user interfaces in simulated and real-world environments are also discussed.

Various cultural aspects could possibly influence the effectiveness of the user interface in a multicultural society. Language is an important factor and studies have shown that simple translation will increase productivity [Bodley 1993]. All eleven official languages do not however contain the necessary technical vocabulary. Mothers from a lower social class typically use a limited language code when communicating with their children [Mussen et al. 1984]. As this cause the children to think in more concrete and less conceptual terms it may influence the human computer interaction, particularly where a high degree of abstraction, like in graphical interfaces, is used.

Symbolism is problematic as symbols like light bulbs, recycle bins and VCR controls do not feature in the life of students living in slum and backward rural conditions. Lack of exposure to technology might negatively influence user attitude [Downton 1991] with a corresponding inhibition of learning and performance. An external locus of control is common among disadvantaged groups due to the high degree of rejection, hostile control and criticism they experience. As the sense of being out of control is largely associated with the inclination to avoid stressful situations, the hostile South African political environment of the past may therefore lead to a situation where students from these groups might prefer to avoid situations where they do not feel in control. The strong differentiation between the roles of the sexes in the indigenous cultures can also influence the encounter with the computer [Downton 1991] as it has been shown that the different orientations towards problem solving can have an important influence on computer usage. The intracultural factors of social class play a significant role in determining how a person acts and thinks [Baruth & Manning 1991]. Such differences may sometimes be more pronounced than those resulting from cultural diversity and may influence the orientation of the user towards abstraction and generalizations. As each lifespan stage has its own unique developmental characteristics, age as an intracultural factor was found to be a powerful predictor of a user's ability to learn complex computer systems [Egan 1988] and it is therefore important to take the age group of expected users into account when designing user interfaces.

Race, being based on the anthropological concept used to classify people according to physical characteristics such as skin and eye colour, provides no culturally relevant information, and can consequently not be considered as an influencing factor.

Due to the subjective nature of cultural factors, complex test instruments are needed to determine the influence of each factor and even if a factor is found to be an important one, the finding does not necessarily apply to all users of a particular system. Few, if any, studies address the problem of interface design for a wide cultural mix. Existing guidelines mostly assume a specific cultural group as the target and base the design upon this assumption.

As it is important for all users to be able to use simple interfaces like those used for automated banking, the first step was to determine if any significant differences exist between cultural groups when using a simple text based interface. Using a simulated interface on a microcomputer network, the time to complete a simple questionnaire in English, was measured for a sample of 277 Cape Technikon students representing eight cultural groups and six languages. The students selected have all been exposed to computers for six months and were at a similar academic level. No significant intercultural differences were found.

In a real life study 2750 students were tested during the annual registration of students at the University of Stellenbosch. Medical, engineering and commercial students were tested for the time they took to complete the interactive registration process. All students were in their second or higher academic year. As in the simulated process, no significant intercultural differences were found, despite the more complex nature of the registration system.

The lack of intercultural difference is not surprising as all students were at equivalent literacy and training levels and did not have to interpret any symbols in terms of their cultural background. This does however point out that text based interfaces does not cause serious intercultural differences in the human-computer encounter. At the time of testing, the technology to test graphic interfaces was not available, but future tests on this type of interface is expected to show much more cultural differentiation. As symbols may be a way of overcoming low levels of literacy, where even people who cannot read can recognize a graphical image, future research will be aimed at the determination of problem areas in symbol based interfaces when used by multicultural communities with low literacy levels and little previous exposure to computers.

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SITUATED LEARNING: APPLICATION TO EDUCATIONAL TECHNOLOGY

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Abstract: Situated learning theory contributes to a growing body of research in the human sciences that explores the way learning derives from participating in social worlds. This theory has found a wide-spread audience through the book entitled, Situated Learning: Legitimate Peripheral Participation (Lave & Wenger, 1991). Lave and Wenger raise key questions about the nature of social settings that supported or inhibited the learning of authentic practices by newcomers. Although Lave and Wenger had warned that situated learning is an analytical perspective, many researchers attempt to use its central notion in a prescriptive way to create better learning environments. The purpose of this paper is to establish how such a relation between the theoretical framework and the application in the field of educational technology can be established. This paper therefore presents: (a) a brief overview of situated learning theory, (b) the implications of the theory for learning and learning environments, and (c) issues arising from the application of situated learning theory to educational technology.

Learning in an online environment provides opportunities for learning to occur within situated learning contexts that are based on authentic tasks (i.e., when programs like Hypermedia and Virtual Reality microworlds are being used, Harley, 1993). These programs can provide contexts of many different types including: (a) the actual work setting, (b) a highly realistic or 'virtual' substitute of the work setting, or (c) in an anchoring context such as a video of the multimedia program (McLellan, 1994). These settings may promote communities of practice as learners engage and interact with the program and with other members of the community. Further these programs provide opportunities for participants to engage in the four strategies suggested by Brown, Collins and Duguid (1989) to promote co-participation in an apprenticeship model. In that within these types of programs participants can engage in collective problem solving, display multiple roles, confront ineffective strategies and provide opportunities to develop collaborative work skills in both an asynchronous and synchronous context.

More often than not, however, non-authentic tasks are frequently embodied in educational technologies. For example, computer simulations that are designed to show flashy pictures, film strips, and other seductive details are less likely to engage the student in active learning, in comparison to other simulations that require problems to be framed and resolved. The former simulations (e.g. eye candy types) do not promote situatedness; thus reducing users to sightseeing tourists, rather than active travelers who make an attempt to try to understand the culture and people of the countries they are visiting (Damarin, 1993).

Students in non-authentic simulations can then be thought of as consumers of knowledge. However, they are shoppers who are knowledge building as they are unaware of what constitutes good value for their learning experience or good quality for their online learning activities. Ruhleder (1995) agrees with this concern, in that information that is presented in an electronic format may be given undeserved authority because of the 'scientific' objectivity associated with technology. Damarin (1993) further suggests that although it may be possible to design hypertext programs that would encourage students to use the languages, the norms and to share the local histories within that context it is highly unlikely. She argues that based on the current direction of educational hypertext development, the use of the principles of situated learning theory is not assured in educational technology contexts.

To provide another example, to date there exists much "educational" media that engages students in practices that are neither authentic nor do they lead to authentic practices. If for example, a chemistry-related activity asks students to shoot chemical formula from the sky as quickly as they can, these students are not engaged in the activities and practices that characterize chemistry. Rather, they learn to react quickly, and at best, to memorize the formulas required by the game. These programs, although entertaining, provide little if any authentic learning experiences for the student and are not transferable outside of the simulation in which it has occurred.

The technology then really needs to be developed using an authentic learning perspective, multimedia based tools can further promote situated learning as learners with diverse knowledge and perspectives are supported. This quality is important in today's classroom environment as teachers are constantly being encouraged to view students as individuals with individual learning styles. A concern that Damarin (1994) brings forth though, is the social and economical situatedness of what sparks the development of a tool and it's later use. These at times, political situations result in the establishment, continuation, modification or demise of various technological tools. This argument suggests the role the larger community of practice plays in the design and implementation of technological tools.

As a result, the principles of situated learning have considerable implications for how educational technology tools have to be designed for authentic learning to occur -- as situated learning has provided the framework of viewing the community of practice as the center of the technological environment (Damarin, 1993; Harley, 1993). As such, technological tools cannot be thought of as separate from the human interaction, as both are integral components of this community of practice. It is then critical that artifacts not be isolated rather that they are woven into the context in which they are to be used in (Brown & Duguid, 1993).

Educational technology needs to promote learners that are actively involved in their learning experience and needs to acknowledge that knowledge is being co-produced by the learner and the context in which it is occurring (Damarin, 1993). Therefore, designers of technological tools need to provide the tools that are required by the learner and as opposed to providing bells and whistles that may never be used by the learner. By following this design method learners are part of the design process and thus moving away from the traditional design model of guessing what the learner will require ahead of time and building the tool (Brown & Duguid, 1993).

Educational technologists need to further design tools in a manner that is commensurable within a situated learning theory. These tools then need to be made available to newcomers to allow for an increased participation into the practices of the community into which the learner is to enter (Brown & Duguid, 1992). That is, this technology needs to be flexible enough to allow newcomers to engage in authentic practices but at the same time allow this participation to increase over time until newcomers are old-timers themselves. That is, educational technology needs to allow for newcomers to engage in a trajectory of legitimate peripheral participation which increases in unison with their increasing competencies in the target practice. This ensures the legitimacy of the technological tool to be introduced into that particular community of learners.

Apprenticeship models can also be supported within the field of educational technology through use of tools such as conferencing systems and e-mail. A good example is the way in which students participate in a collaborative assignment for an online course. Initially, an old-timer would explain or demonstrate the technical aspects of the tool to be used to the newcomers, thus promoting a community of practice. These students would then develop their ideas through sending messages back and forth to determine the focus of the particular assignment (e.g., through use of a conferencing tool such as V-Groups in the Virtual University). Once the focus was determined, students would continue collaboration through the medium until the assignment was completed. Thus, both the old-timer and newcomer are active participants in the community of practice.

This ability to participate in a community of practice asynchronously is critical to the success of the online courses that are currently being offered at university campuses worldwide; as students who are not able to make it to campus are now able to feel that they belong to a larger community, something that the traditional model of distance education (the correspondence model) does not allow for. As education is moving towards a model that incorporates technologies it is critical that situated learning theory is taken into account in order to ensure that authentic learning experiences occur. This use of technology further ensures that connections are developed and maintained between the learners and their community of practice (Brown & Duguid, 1993).

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A Sociocultural Approach to Understanding Distance Learning

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Abstract: This investigation documents how collaborative processes of knowledge construction over time and space are structured and organized utilizing two-way video conferencing strategies for distance education in an undergraduate course in child development at two universities. The impact of a learning-centered approach to video conferencing, the on-going technical and organizational support needed to sustain changes in pedagogy using new technologies, and the mediating force of television frameworks are discussed.

This study examines a year-long collaboration among organizers from two universities who designed and implemented two-way video conferencing and email activities as an integral part of a child development practicum. Each quarter the two classes met four times for video conferences that lasted one-hour and twenty minutes. In addition to following the same syllabus, all students at both campuses conducted fieldwork with children in a unique after-school program centered around computer-mediated learning known as The Fifth Dimension. The practicum encouraged university students to combine theory and practice. The distance learning (DL) element of the course was envisioned as a medium through which students would share their empirical/theoretical syntheses in a collaborative learning environment. Students were expected to be active participants during the video conferences and lectures by professors were kept to a minimum. This scenario is unlike the usual DL environment where one professor, teaching from a host school, instructs students at his/her site as well as students at a distant site. In this more common arrangement, models of traditional classroom teaching are imported wholesale into the videoconferencing setting; i.e., the DL course is conducted by one instructor who lectures to a relatively passive audience of local and distant students. The project discussed here was carried out by two professors every quarter who collaborated with one another and with a research assistant whose job it was to plan the video conferences and provide the support necessary to carry them out. While much of the literature on DL emphasizes the supposed need to imitate as closely as possible the "normal" classroom setting, the goal here was to implement a use for the technology that went beyond the average university lecture. The child development practicum was organized to move beyond the traditional dichotomy of teacher-centered vs. student-centered to a more productive use of instructional technology that was *learning-centered* [see Lave & Wenger 1991] -- - an approach which reflects the complexities of strategically organizing interaction so that responsibilities for participation continually shift among participants.

The research questions explored here include 1) What elements of the instructional approach to DL contributed to students' active knowledge construction? and 2) How was collaboration facilitated and/or constrained between the two universities? To investigate these issues, participant observation fieldnotes by undergraduate students, support personnel, and instructors were gathered. E-mail correspondence among students and program implementors were collected for the duration of the project. In addition, social interactions were documented between and among participants utilizing two data sources: video tapes of the DL classes and a Web page that provided a bulletin board and chat room options. Semi-structured interviews of undergraduate and elementary students were gathered to verify attitudes and assessments found in participant observation fieldnotes. Interpretations of data were informed by socioculutral theories. In these paradigms the assumption is that knowledge production cannot be studied independent of the social context and that cognitive skills are considered to be promoted through joint activity (proximal and distal), see [Cole & Cole 1989], [Stone 1996], and [Vygotsky 1978].

The main findings of the research included the following:

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* Particpation in DL classes with a group of students who were attempting the same kind of fieldwork and struggling with the same theoretical materials created a broad sense of shared purpose for the undergraduates and positivley influenced their attitudes toward the coursework.
* The role of the professors was to moderate the conference and to follow-up on presentations made by students. Their participation was evaluated positively when they briefly elaborated on or re-directed students' understandings of the key theoretical concepts, and was evaluated negatively when they resorted to lecturing for more than ten minutes. Students were the least tolerant of lengthy lectures delivered by the distant professor. Many students even assigned malevolent intentions to the professor from the distant campus, writing that he or she was trying to "show off" or "take over".
* The undergraduates who were either called on or who volunteered to share theoretical interpretations of their data gave the most positive evaluations of the video conferences and reported being proud of their demonstrated abilities to interpret the readings and effectively apply the relevant concepts. Non-presenting students wrote that they were able to develop more sophisticated understandings of the theories after hearing the examples outlined by their peers and by participating in the resulting discussions.
* The students reported in DL fieldnotes that the possibility of having to present their ideas on "television" to an audience of distant peers led them to carry out their assignments with a great deal more effort than they ordinarily would have invested.
* The television framework for social interaction did not always lead to a collaborative learning environment. Students reported that since speaking was such an "event" in the context of videoconferencing (i.e. the camera operators, audio technicians, moderators and distant audience members all had to gear up for participants) the they did not feel comfortable making brief supportive remarks such as "I agree" or "That was interesting".
* The distance made it possible for students to be less considerate of their peers at the other campus and they had a tendency to be more judgmental about their ideas and comments. However, these dynamics were discussed in the regular classroom settings and the students at both campuses reflected openly about these tendencies and often tried to make up for misunderstandings by writing supportive email and by thanking participants during the video conferences.
* The success of this videoconferencing endeavor was due in large part to a research assistant, whose job it was to plan the video conference by delineating the structure of who talked when and by providing support in terms of the technical aspects of video production[1]. In order to coordinate between the two university sites, the research assistant attempted to stay in continual contact with the course instructors so that an adequate degree of shared meaning about the collective process of on-line collaboration could be maintained. Her supportive role was critical to the effective implementation of videoconferencing given the continual change in site instructors and their multiple realities.

Despite the discontinuities brought into the activity by multiple faculty participants and the sometimes inhibiting framework of television, collaboration in this setting was successful in terms of overall program goals: active on-line engagement and co-production of knowledge. Promoted here is the view that learning-centered collaboration across distance can be a powerfully validating force for undergraduates struggling with the challenges of ethnographic fieldwork and theoretical applications.

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Computer-mediated Learning and the Collaborative Construction of Mathematical Knowledge

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Abstract: This study explored computer-mediated learning in an after-school club, in which elementary-aged children worked with undergraduates from a local university. Collaborative participation by undergraduates was characterized as requests for explanations, information, suggestions for off-line tool use, and displays of encouragement. Computer software designed for single-users was shown to constrain collaborative talk-in-activities and the co-production of mathematical knowledge.

This is a preliminary investigation into the collaborative construction and communication of mathematical knowledge during computer-mediated learning activities so that we may better determine design requirements of software. In particular, this study focused on opportunities for undergraduate students to collaborate with elementary-aged children on commercially available computer games in an after-school club. Social interactions during collaborative learning events involving computers potentially stimulate mathematical knowledge construction. This study examines the routine practices used to accomplish computer games and how this mediational tool both constrains and encourages children's development of mathematical knowledge. The research findings in this study examine mathematical problem-solving discourse involving computer games to expand our understandings of the processes of collaboration in computer-mediated learning and our understandings of the interaction between software and activities designed to be collaborative.

Sociocultural views of learning and development, the theoretical framework for this research, hold that cognition is "socially constructed", "socially distributed", and "socially organized", see [Crook 1994] [Ochs 1988] [Stone 1996a] [Vygotsky 1978]. From this perspective, it is assumed that knowledge production cannot be studied independently of the social context. Further, cognitive skills are considered to be promoted through joint activity in which semiotics (tools and signs) mediate development during social interaction.

Our research was guided by the following research questions: 1. What is the nature of collaboration during computer-mediated learning involving mathematics. 2.How does mathematical game software influence the collaborative production of mathematical knowledge?

To document the social processes of collaborative learning and computers, qualitative methodologies were used in this study. The data in this study are taken from a larger investigation into the development of mathematical and scientific literacy in an after-school club. The after-school club is located in an urban school district with a predominately Latino student population in the southwestern area of the United States. In this club, children worked with undergraduates from a local university who were enrolled in a child development practicum that required them to participate in the club twice a week for nine weeks. The goal of undergraduate participation was to connect theory to practice by reflecting on and using social theories of human development as they worked as tutors. The corpus of data consisted of 10 videotaped sessions of approximately one hour in duration.

To illustrate the significance of pairing undergraduates with elementary-aged children, this study focuses on Puzzle Tanks, a computer game designed for one player and consists of four levels of difficulty [O'Brien 1985]. The goal of the game is to measure out a specific volume of liquid by filling and emptying tanks, as well as transferring liquid from one tank to another. The lowest level of difficulty, *Beginner* level, uses two tanks and one storage container. At this level, problems are generated according to a formula that determines the desired amount of liquid to be transferred into the storage container. This formula is $x = m \cdot a + n \cdot b$, where x is the desired volume, constants $m,n \in Z$, and $a,b \in N$ are the tank capacities. Because any values chosen for m, n, a, b will result in a value for x, all problems in the beginning levels have a solution. Higher levels of the game generate random integers, resulting in the possibility of no solution. Specifically, children are expected to create a solution to a relatively novel situation by utilizing some sequential combination of addition, multiplication, or subtraction procedures to determine the produce value.

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The main findings in this research included the following:

- Undergraduates, in the role of a tutor: a) socialized children's attention to important aspects of mathematics activities on computers (e.g.,critical information found on the screen by encouraging children to read directions when initiating a game or when problems of understanding arose; b) encouraged off-line tool use by suggesting that students use paper and pencils to figure out difficult problems; c) contributed to children's opportunities to communicate about their mathematical knowledge by asking for explanations and justifications (consistently found in this data set) and, d) contributed to the joint construction of motivation for continued play through questions and responses to students' actions also created opportunities for the co-display of interest in the game and solution strategies. As a consequence, motivation for continuing a game was not solely an individual construction but a result of the social organization of the collaboration.
- Although the computer games in this study were purposely framed as collaborative activities through the use of adventure guides, i.e., directions for how to play the game embedded in a fictional narrative, it was still very common for children to begin a game by randomly clicking the mouse on various areas of the screen in an attempt to determine specific game procedures. The pattern of random exploration was found to be consistent across computer games; there is an interaction between the affordances of software and how collaborative mathematical activities unfold.
- The design of PT software technology fits into the general single-user paradigm typified in current commercial software; as such this software will *permit* social interaction but it is not designed to encourage it, in fact, it is oblivious to social interactional processes. Consequently, this form of software constrained activities organized to promote the co-production of mathematical knowledge. The common pattern of students focusing on the screen persisted even when undergraduates offered suggestions that required either a response or off-line involvement.

In conclusion, the collaborative activities with undergraduates evidenced varying degrees of participation by children. For example, it was common for undergraduates to assist children in focusing on important aspects of computer-games, e.g. screen displays. This form of assistance, however, appears to be successful only when students were experiencing troubles with the game. When problems were not sufficiently difficult to stop play, children would continue to use the mouse, paying little attention to the information on the screen. Undergraduate participation also encouraged the use of off-line tools such as paper and pencils to represent of problems. However, the computer game's similarity to video games, i.e., a single-user approach, made it easy for children to continue using the mouse and ignore any suggestions offered by the undergraduates. In other words, the software design encouraged individual involvement rather than collaboration. Collaborative talk-in-work, then, was not an intended by-product of the software design but rather a product of ongoing problems with understanding or game procedures.

While many of the strategies for collaboration used by the undergraduates did not necessarily lead to the co-production of mathematical talk or reasoning, that was not the case for explicit requests for explanations. When undergraduates asked children what they did to accomplish the task, these question frequently resulted in children producing explanations. Nonetheless, these explanations tended to be brief or provided no evidence of a deep understanding of mathematics.

The significant issue is the interaction between expectations for collaboration and the constraints placed on both knowledge production and collaboration by the software. For example in PT, there is no way to manipulate problems to investigate patterns of similarity and differences. As a consequence, it would be difficult for Ivan to explain why any one problem was impossible outside of stating that no combinations worked. Had the "presented problem" been directed toward finding a pattern, PT may be a much more valuable tool insights into mathematical principles. It is crucial that differences in problems be systematically explored given that exploration of the mathematical patterns found in solution strategies provides children with opportunities to construct a deep understanding of principles underlying mathematics, see [National Research Council 1989], [Steen 1988], and [Stone 1996b].

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Knowledge Engineering Ontologies, Constructivist Epistemology, Computer Rhetoric: A *Trivium* for the Knowledge Age.

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Abstract: In this (largely speculative) paper I want to suggest that certain ideas which have recently been developed by knowledge engineers can fruitfully be applied in the educational context. I have two main reasons for thinking that this is so: firstly, ideas from knowledge engineering have been applied in the past with some success; secondly, over that last five years or so there has been a paradigm shift in knowledge engineering away from a mining-and-transfer view of knowledge acquisition to a constructivist, modelling approach which has broad similarities to currently prevalent ideas in educational theory. Briefly put, knowledge engineering can provide the conceptual and other tools which can facilitate the construction of *knowledge models*. The relevant knowledge engineering ideas are illustrated with a knowledge model from the archaeology domain and the possible benefits for learners are outlined.

In this paper I want to suggest that recent developments in knowledge engineering have much to offer as the basis for a modern *trivium* which will enable learners to cope with the expansion in the availability of information. This *trivium* consists of ontological and other (problem solving) categories from knowledge engineering, a basically constructivist rather than mirroring approach to knowledge and, finally, computational models of argumentational structures.

The currently dominant educational paradigm of constructivism can be seen as the view that meanings and knowledge are constructed by learners actively interpreting their experience [Nicaise & Barnes 1996; Jonassen et al. 1993; Perkins 1991; Duffy & Jonassen 1991] usually in collaboration with other learners. Many constructivists also espouse the idea that students should be expected to cope with "authentic" problems; an idea from research on situated cognition [Brown, Collins & Duguid 1989].

At the same time there has been a move in knowledge engineering away from the view of knowledge as a stuff to be extracted and poured into representation formalisms to one in which the engineer, in cooperation with the expert and users, creates models of the problem solving activities in a domain. The KADS knowledge engineering methodology [Schreiber et al. 1993; Tansley & Hayball 1993] is centred on the development of a series of models.

For the constructivist educator, recent developments in knowledge engineering provide a set of components which can be used in knowledge modelling by learners. Since these modelling components cover both the domain contents and the problem solving which operates over these, they should provide a basis for student acquisition of domain knowledge (including problem solving) and meta-cognitive skills such as the selection of problem solving strategies. The tool I envisage differs from that discussed in [Conlon & Pain 1996] in that the full range of modelling components will be made available to students. This is partly for flexibility in modelling but also because it is more likely that problem solving and meta-cognitive skills will be acquired if a range of problem types and problem solving methods is encountered. The important components are outlined in the following:

Ontologies: Using air photo interpretation (of Romano-British archaeological sites) as an example, the ontology which is relevant to the domain is an intersection of the set of terms (and relations over them) for describing air photos (e.g., shadows, linear features, irregular features) and those for describing Romano-British building structures (e.g., domestic, military, commercial, fort, fortlet, camp). Ontologies provide the learner with a clear and consistent domain terminology which can be used in collaborative model construction, and a means of structuring the domain concepts in terms of relations.

Domain Descriptions: In accordance with the ontology as given above, the domain description consists of a series of instantiated relations. The construction of these will involve the learner in a process of knowledge acquisition (in the engineering sense). In archaeology, the outcome of the process will be equivalent to the section of an archaeological report which includes full details of some aspect of the archaeological record. In addition, the engineering process assists in the acquisition of various relations between concepts which would

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not commonly figure in an archaeological report. This immersion of the learner in a domain should ensure that at least this static knowledge is retained.

Problem Solving Methods: Problem Solving Methods (PSMs) are templates which indicate the tasks to be carried out in a problem solution, the structure of these tasks and the types of domain items to be operated on. They are not algorithms for problem solving; in fact, many different algorithms can be derived from them. Given a view of air photo interpretation in which particular features (e.g., rectangular foundations) are evidence for particular archaeological structures when other evidence, such as the relation to other structures, is taken into account, the most suitable problem solving method here is Heuristic Classification. Heuristic Classification operates on Observables (such as the location of linear features) to produce Solutions (e.g. "This photo contains a Roman fort"). It does this by abstracting Observables into Descriptions (here lines, areas and air photo features are abstracted into higher level descriptions) and matching these to Abstract Solutions (here, descriptions are mapped to building structures). Whether constructed or retrieved from libraries, PSMs are especially useful since they are not usually recorded or represented in normal disciplinary discourse. In addition, while PSMs are primarily models of problem solving skills, it is possible to model meta-cognitive processes such as PSM selection and validation since these are also problem solutions.

Although there is a difference between knowledge engineering (where the goal is the production of models which can be used in the design and implementation of a fully working system) and education (where the goal is an increase in the ability of learners to differentiate between types of knowledge, to acquire new knowledge, to communicate about their knowledge and to apply their skills in real life situations), I would suggest that the following are the likely benefits to the learner in making use of knowledge modelling components:

1. Knowledge models can be collaboratively developed (i.e. constructivism in practice) with opportunities for student role-playing;
2. The model components and domain description vocabularies will provide students with a common language (which can be more or less precise depending on their educational level);
3. Students interacting with knowledge level models will come to understand that there are many different types of knowledge, that domain descriptions can be used for many different problems and that the same problem solving strategies can be used across a number of domains.
4. These models are useful as a means of learning domain contents, problem solving skills, meta-cognitive strategies and domain discourse(s).

A tool built using recent ideas from knowledge engineering is not only largely consistent with constructivist ideas, it may provide the means for achieving some of the larger ambitions of constructivist researchers (such as the development of meta-cognitive skills). I say "largely consistent" since I am unsure to what extent the modelling framework provided by knowledge engineering is flexible enough for truly constructivist modelling. I suspect however that some structure (and therefore inflexibility) is needed if an environment is to act as a modelling environment. Given this, it is largely up to the learner to acquire the modelling and other cognitive skills necessary for the effective use of the new tool just as medieval students had to learn logic, rhetoric and grammar. The question of whether knowledge engineering provides the appropriate structure will be resolved when a system based on these ideas is built and tried out by learners.

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Using the Reeves and Harmon Instrument to Evaluate Interactive Multimedia

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Abstract: The Reeves and Harmon instrument, designed for use by expert designers and users of interactive multimedia (IMM), was tested with 5 CIS acedemics to determine its viability. These users found that the instrument required too much of a grounding in pedagogical priniciples to be usable by them.

1. Introduction

The lack of adequate instruments to assess ease of use or usability of software has been acknowledged in the literature. This poses problems for those who must try to assess and make choices from among competing packages especially when the application to be evaluated is an educational one and must take in the learning outcomes as part of the evaluation process (Kraiger, Ford and Salas, 1993). Reeves and Harmon (1993) developed an instrument for expert designers and users of Interactive Multimedia (IMM) which they feel can adequately elicit the subjective reactions of users of applications of this genre.

A computerized version of this proposed instrument was constructed using the authoring tool, Toolbook,with links to a database developed using DBASE IV. (Thomas and London, 1996). Five CIS academics were asked to use the instrument to evaluate an IMM CD-ROM used in an Introductory Multimedia course. The consensus was that the instrument was far too complex for use by them, requiring as it did the user to have strong grounding in pedagogical principles.

2. The Instrument

Reeves and Harmon's (1993) instrument suggests that multimedia instructional applications should be evaluated on 10 user interface dimensions - ease of use, navigation, cognitive load, mapping, screen design, knowledge space compatibility, information presentation, media integration, aesthetics, overall functionality, and 14 pedagogical dimensions - epistemology, pedagogical philosophy, underlying psychology, goal-orientation, instructional sequencing, experiential validity, role of the instructor, value of errors, motivation, structure, accommodation of individual differences, learner control, user activity, cooperative learning. These are assessed on various continua, rated from ten to zero.

A graphical representation of the matrices of both dimensions is similar, each being plotted on a set of continua that are measured on horizontal axes. The User Interface dimensions continua move from "Negative Design Principles" to "Positive Design Principles" in a leftward progression. Therefore, if an assessment graph tends to be more predominantly to the right of the matrix, the application can be assumed to embody better design principles than one whose assessment graph tends to be more to the predominantly to the left of the matrix. The Pedagogical dimensions continua move from what we call "Generic Learning" to "Individualized Learning". Therefore, if an assessment graph tends to be more predominantly to the right of the matrix, the application can be assumed to foster individualized learning, while if the graph tends to be more predominantly to the left of the matrix, the application can be assumed to foster generic learning. It is important for both the evaluator and the interpreter of the evaluation results to remember that while the User Interface assessment graph is a critique of the application, the Pedagogical assessment graph is a critique of its instructional content and approach to learning.

A clear strength of the Reeves and Harmon approach is that educational applications can *all* be assessed by the *same* criteria, thereby removing subjectivity and bias.

3. Pilot Study

The purpose of the study was to determine the viability of using the Reeves and Harmon instrument to evaluate IMM. Five CIS academics were asked to use the computerized version of the instrument to evaluate an IMM CD-ROM tutorial which came as part of a textbook used in an introductory multimedia course and to answer some open-ended questions

4. Results

Based on the assessment made by the authors of this paper, the IMM CD-ROM was judged to be average on all the User Interface dimensions. Pedagogically, it was estimated that it's design was based more on the Generic Learning model than on the Individualized Learning model. As a group, the raters agreed with the authors' assessments. More dimensions were rated as conforming to the Generic Learning model than to the Individualized Learning model. And, as expected, the Interface Design dimensions were all rated as average. In terms of the individual ratings given, however, a lot of variability was exhibited.

To the question on ease of completing the evaluation, three evaluators deemed it Not at all easy, one as Very easy and one as Easy. The overall reason for it not being easy to complete was an inability to fully understand the meaning of the dimensions. To the question of whether any other dimensions or criteria were missing, most expressed not being competent enough to answer the question, that is, not being a "learning expert".

5. Conclusion/Implications

Even with a small sample size, it is evident that the Reeves and Harmon instrument is too complex for use by end users untrained in the learning disciplines. The Pedagogical dimensions were particularly troublesome. As they note in their article, the instrument is designed for use by expert designers and users of IMM.

The sample solicited was unable to elucidate more appropriate criteria on which to make the evaluations. Could it be that the criteria used to evaluate textbooks might be a more appropriate basis on which to evaluate and compare IMM applications? That being the case, the content rather than its underlying pedagogical philosophy may be more meaningful. Issues such as completeness of material coverage, clarity, structure, lesson difficulty, use of examples and media, etc. may be more appropriate than whether the content is structured based on a particular pedagogical school of thought. Research in the area must continue to investigate these or other more appropriate criteria.

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Expanding Horizons Via Telematics: an Interactive Process Among Children and Adolescents

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Abstract: The purpose of this work is to present aspects observed in the communication of cerebral palsied children and adolescents with peers from other countries using internet. We think that such aspects are particularly important in the student's growing process within today's historical moment towards an "intercultural globalization". Some of the referred aspects are, among others, interchange of ideas and cultural and geographical information, motivation to learn more about their own context, attitudes of responsibility and autonomy, desire to expand their own horizons, respect for other ways of living, and valuing themselves.

The work developed at the Center of Informatics for Special Education of the Federal University of Rio Grande do Sul, south Brazil, has as its main focus to promote the interaction/communication among children and adolescents with cerebral palsy, from the state capital, Porto Alegre, and from other countries (Portugal and Canada). Collaborative activities such as newspapers and stories in addition to the interchange of messages about different topics have taken place. Within this context we have observed that in an initial stage, the students need to know more about their virtual pen-pals in terms of understanding more about their hobbies, families, schools, musical preferences, etc. In a later stage, this curiosity seems to move towards a wider scope - that is, the cities where the pen-pals live, local holidays, typical and regional food, turistic places and the most practiced sports.

An interesting aspect to be highlighted in this telematic interaction is the "break of frontiers" that seems to occur. The natural way through which these youngsters communicate among themselves, suggests that things such as nationalities and geographical and cultural frontiers are no longer relevant in the friendly relationship that emerges among pen-pals. Thus, the feeling of "becoming friend" to distant peers seems to occur due to commonly shared interests and the way in which these students express themselves in the messages sent. They seem to perceive one another just as new friends in distant places. They relate to one another with respect for their differences besides valuing themselves.

The communication among these youngsters through computer network seems to have fostered situations of permanent knowledge construction. Since the students wanted to share their own world, context, state, and country with their pen-pals, they began to pursue current and more accurate information on their own. They were also concerned about writing in a clear and correct way demonstrating attitudes of responsibility and autonomy. Thus, comparison and confrontation between the new knowledge and the knowledge the students already had, was a recurrent characteristic. This process provoked both the rise of new questions and the need for new explanations, which seemed to point out to sociocognitive conflicts.

Previously to such electronic communication, the youngsters already had preconceived ideas about the countries involved in the exchange. During the electronic communication, we could observe the students' interest in checking whether or not those ideas were correct. For example, the Canadian students thought that in Brazil, rain forests, wild animals and exotic indian tribes were part of the daily life of their Brazilian friends. They had also read that because of the high inflation in the country people were forced to get rid of the bills, burning them on the streets. The Brazilian and the Portuguese youngsters, on the other hand, found out that in spite of the fact that both groups spoke the same language, many words had different meaning in the two countries, and that the way in which some holidays were celebrated also differed. Furthermore, they became aware of the influence of the hemispheres in determining the different seasons. Messages from their web-friends in which the students referred to a season which was different from the one they were going through enhanced curiosity to know the geographical location of the countries involved.

In sum, our observations suggest that the interchange of ideas and information that takes place through computer network, can be extremely rich and occurs in a spontaneous and natural way, which makes them meaningful for those involved. The students' curiosity in relation to the expansion of their own world view, by getting to know other forms of living, respecting the differences, in a simultaneous process of acceptance and valuing of themselves, were remarkable characteristics. In addition, the students also felt motivated to know more about their own context, showing attitudes of responsibility and autonomy. Knowing how to efficiently communicate using new technological resources and learning how to expand the notion of local "community" towards a world level are crucial elements for a more relevant and meaningful performance in the current and future society.

Comparing a Text-based Intelligent Tutoring System to Intelligent Multimedia Software

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Abstract: A three part empirical study is underway to determine whether or not college students can learn C pointers more effectively with the aid of computer software. Lecture alone has proven to be of little success in teaching these concepts to many students. The experiment consists of tracking the scores of novice C programming students on questions about pointers. The control group received lecture notes accompanied by classroom instruction. Treatment group one received the same notes and lecture but were introduced to a text-based intelligent tutoring system covering the basics of C pointers. Treatment group two received the same lecture and notes as the previous two groups, but was given the opportunity to use a multimedia version of the software. The experiment was carried out over three fifteen week semesters. This paper presents a summary of results obtained thus far, an evaluation of the software by the users, and compares the two tutorials.

Introduction

In an effort to help novice C students understand and use pointers correctly, two pieces of software were developed that focused on pointers. The first piece of software, CPR, C Pointer Remediation, is an intelligent tutoring system (ITS) that covers pointers to variables, arrays, and pointers to structures. The second piece of software, CPR_MM, is a multimedia version of the tutorial. Both tutorials contain the same pedagogy. Both versions teach identical concepts. It was our intention to offer these two tutorials to students in an effort to study the learning effects and use of the two versions of the same software, compared to students who learned pointers without the aid of software.

The Experiment

A three part experiment was initiated at Montgomery College in Rockville, MD. The control group (C) consisted of thirty-eight students who completed introductory C programming classes taught in the fall of 1995. This group received notes and classroom lectures, but no software to help them learn about pointers. The first treatment group (T1), derived from forty-two students who completed the classes during the spring of 1996, received the same lecture notes and were also provided with CPR, C Pointer Remediation, a text-based intelligent tutoring system. The second treatment group (T2), consisting of thirty-four students who completed C programming classes during the fall 1996 semester, had access to CPR_MM, the multimedia version of the software. All classes were taught by the same professor and used the same notes.

The subjects were not coerced, nor were they given any extra credit for using the software. It was our intention to give T1 and T2 subjects free copies of the software, for use on home computers. In order to obtain a copy of the software, the subjects were required to bring diskettes to the computer lab. CPR requires one high density diskette, can be run from either DOS or Windows, requires a PC with a minimum of a 80286 processor, and does not require installation on a hard drive. It uses menus and commands consisting of a single keystroke for navigation. CPR_MM requires four high density diskettes on which to store the compressed files, and a PC with a Windows interface, a sound card, a 80386 chip or better, eleven megabytes of hard drive space for installation, and a minimum of a VGA monitor. Navigation is by mouse.

CPR is the superior piece of software from a pedagogical standpoint. It detects all correct answers and the top four incorrect answers to questions generated by the software. It has a student model that estimates the amount of knowledge that any user possesses on a given concept. It contains a module that allows the user to type a function as if in the editor of a C compiler. The multimedia version, CPR_MM, written in an authoring system, contains the same concepts and wording, but is not an ITS. However, it contains sound and animation. It does not have an accurate student model. Additionally, because of limitations imposed upon the programmer by the authoring tool, each correct answer must be added to the system individually. Therefore, CPR_MM does not necessarily detect all of the numerous correct responses. Some responses can not be typed at all, due to idiosyncrasies of the authoring system, and must be stored as multiple choice type answers.

Each treatment group was exposed to only their particular version of the software. Each subject evaluated their software and chose whether or not to obtain a copy. The ratings of both versions of the software were good. On a scale of 1 to 5, with 5 being the top score, the average rating of CPR was nearly 4.0; that of CPR_MM was .5 higher. However, the number of students who reported actually using the software was rather disappointing: 40 percent (17 of 42 CPR subjects) and 38 percent (13 of 34 CPR_MM subjects). . It should be noted here that one reason that the numbers were so low may be that the subjects in the experiment were those still enrolled in the course at the time the final exam was administered. There is approximately a fifty percent dropout rate of students in this programming course. It is possible that the students more likely to use the software, i.e. the less confident students, were eliminated by the end of the study because they were not present to take the final exam or answer the final software usage questionnaire.

Subjects were tested six times over the fifteen week semester. Those who did not use the software scored nearly eight points better on their midterm exams, administered prior to the introduction of the software, than those who used the software. A statistical analysis of the five measurements following the release of the software indicated no statistical differences in scores between any of the groups. However, CPR users reported that they used the software an average of 4.1 hours; CPR_MM users reported 4.6 hours of use. Non-users of the software reported that it took them between 2 hours and 2 months to learn pointers. CPR users were about three years older than the non-users. There was no difference in the ages of users and non-users of CPR_MM. The students who used CPR tended to be poorer students than those who did not use CPR. There was no apparent difference between type of students who used or did not use CPR_MM. At the end of the semester, the CPR software was rated higher, by 4 tenths of a point, than the multimedia software in response to how well it helped the students learn C pointers.

Who actually learned more? The multimedia users, who spent more time using their software, and had the benefit of animations, actually pulled their scores closer to those of the control group than the ITS users. We were surprised at these results because the ITS was clearly the better software from the point of view of the educator. However, it was more difficult for the subjects to use. The CPR users had more trouble with disorientation compared to CPR_MM users. The CPR users were also less enthusiastic about the software than the CPR_MM users.

Given the high ratings of the software, we were surprised that more subjects did not report using it At the end of the course, we asked the multimedia group to choose which method of instruction they preferred. Seventy three percent of them said they would rather have an instructor, eighteen percent chose the software, and only nine percent chose a combination of software and instructor. Given the general attitude among educators that software is going to be a big boon to learning, we did not expect these answers. It seems that, at least among college aged students, there is not a great deal of confidence that software helps one learn. However, the evidence suggests that students learn as well using software as they do with any other method.

Gaining Practical Experience through a Media Mix Course in Environmental Chemistry

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Abstract: Inorder to make students gain experience in solving practical problems in the field of environmental hygiene a course was developed by a team consisting of both teachers and experts, working with engineering companies and research institutes. The resulting course was a multi media mix centered around existing computer software used by the experts. These experts also markedly influenced the content of the course. The result is a wide variety of student activities in the course and a high appreciation of the topics by the students. The course is still developing and new media are being used to enhance efficiency and effectiveness.

Introduction

In the first years of the educational program students say: "It is all a lot of theory, what about real life practice?" And, for example during internship with an engineering company, a government agency or a research institute, we hear professionals say: "These young engineers do not know where to begin when facing a professional problem and they cannot even write a proper report, let alone present it in an orderly way".

In an attempt to present a true image of environmental engineering practice, we integrated the necessary theoretical concepts that we already used to teach and at the same time enabled students to practice skills in both problem solving and presentation. In the Department of Laboratory Research of our institute the existing course in Environmental Chemistry was found to lack sufficient links to real-life environmental problems. The idea arose to develop an interactive video program on environmental chemistry. The result however ...

Objectives, means and media

Environmental chemistry studies behavior and fate of pollutants in the environment and the methods that can be used to identify and measure these substances in air, water and soil. Pollutants are emitted into the environment, transported by wind and water and in the process they are being altered by physicochemical and biochemical processes. Environmental chemists work in multidisciplinary teams together with e.g. civil engineers, toxicologists, experts in urban planning and juridic advisors. Together, they assess the risk of past or future pollution and suggest and implement ways of remediation and prevention.

The project team decided to first define the objectives of the course and only after that decide which means or media would be apropriate to realize these objectives. The new course was developed to enable students to:

- solve "real-life" problems in the field of environmental chemistry and environmental hygiene;
- understand and apply the theoretical concepts in environmental chemistry concerning the most common pollutants' effects in the environment and their behavior;
- get acquainted with the ways in which professional environmental engineers tackle pollution problems;
- value the multidisciplinary character of environmental engineering.

In view of the proposed integration of environmental chemistry into the whole of environmental engineering, the course was given the title "Applied Environmental Chemistry".

Development: the role of the experts

Professional environmental engineers were asked to design one module of educational material around a case study, obtained from their own experience. They were only given a theme and a set of objectives, serving as design specifications. The project team anticipated that all experts would want to alter the objectives given by the project team, which they did indeed. A good deal of our original objectives, however, was not altered.

Also with respect to educational media, other than professional simulation programs, our contacts with companies and research institutes proved to be very useful: we came across a promotion video tape that, at first glance, would be eminently suitable to be used as an introduction in problem solving in the field of soil contamination. Indeed, the problem presented was used as the case study in the first, indroductory, module. In cooperation with a company that develops and sells soil research equipment, we realized a slide show on soil drilling and sampling.

But the most important contribution the experts made to the course was the emphasis they put on all kinds of practical details, having to do with organisation, management, cost and environmental policy. By doing so, they made far more clear than the project team had expected, the importance of a multidisciplinary approach of environmental problems and of skills our students should practice in the field of project management.

Student activities

Now, what are students supposed to do in this course of Applied Environmental Chemistry? All modules present a problem in the form of a case study. In a more or less guided tour around this problem, students use a specific heuristic to solve it. This heuristic for problem solving consistis of the following steps:

- description of the problem: what's the situation?
- analysis of the problem: causes/results and boundary conditions.
- generation of possible solutions.
- selection of the "best" solution.
- implementation of the solution chosen.
- report and evaluation.

Multi-media?

We looked for the best media to achieve the established objectives in the context of the type of education where the course would be used. The result was a mix of old and new media. Where we wanted to purely transfer information in word and writing that could easily be presented in a lineair way, paper appeared to be the carrier of choice. Understanding processes requires moving images or combinations of image and sound, in which case the use of video, slides or multimedia programs is obvious. We also incorporated some existing audiovisuals into the course in order to achieve an attractive mix of student activities. The use of computer simulation was apropriate to make students visualize and handle theoretical concepts in real situations as presented in the cases. The resulting mix of student activities was developed at relatively low cost, was easily implemented in various departments of our institute and in other institutes and was easily accepted by teachers because of its open and modular structure. Furthermore, it is flexible and teachers can adapt and extend it with their own means, as e.g. a supporting web site on internet.

Since the course Applied Environmental Chemistry was only started formally in september 1995, it is only possible to draw some preliminary conclusions. So far, it turns out that students are highly motivated to solve the problems presented in the modules they use in class. Only in a few years time we will be able to state wether or not students show a more professional attidude towards problems they face during internship or in their first job. Teachers agree on the following points:

- cooperation with experts in developing the modules was instructive and motivating.
- case studies present a true mirror image of every day engineering practice.
- contacts with professional authors paved the way to state of the art educational materials.

PLAN-PILOT-PRODUCE-PROBE: A MODEL FOR DELIVERING SYNCHRONOUS AND ASYNCHRONOUS DISTANCE EDUCATION

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Abstract: Atlantic Community College has a college-wide planning process. One of the goals developed in the plan is: "To enhance classroom instruction through the exploration and integration of appropriate informational technologies and pedagogical techniques while maintaining the personal aspects of education necessary to community college students." Because access is a problem for many community college students, the college decided to use technology to offer courses in a distance education format. We decided to offer courses in both synchronous, real-time video format and in asynchronous, computer-mediated format in Fall of 1996. In order to do a quality job we decided to plan first, then pilot, then evaluate, and finally incorporate the technology into courses for the entire college.

PLAN

Planning involved selecting the courses and teachers and securing the proper hardware and software. In this presentation, we would like to present the model used: the forms developed and the decision process. The courses selected for the pilot were elective courses, because we did not wish to have students new to the college or students in required courses deal with the new technology. The two presenters were selected as part of the pilot faculty.

Securing the hardware and software involved working with external agencies. The State of New Jersey provided money for every college in the state to set up a room capable for the delivery of live, full-action video. There was no money and no infrastructure to connect the rooms. The college used a Challenge Grant to equip a second room at a satellite campus so that courses could be delivered simultaneously at both sites.

For the asynchronous course, FirstClass software was selected. Students were told that they must have an Internet provider to join the course and that the college would provide no help with hardware problems. The Student Services area of the College was kept aware of developments in the planning phase, and the pilot courses were clearly noted in the tabloid. A handout was prepared for the counselors so that they could answer student questions.

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PILOT

The courses piloted were Financial Accounting and Nursing Management in the synchronous area, and Self Management, a liberal arts three-credit psychology course, for the asynchronous mode. The Nursing Management course was taught by presenter Joyce Grohman and another faculty member. The Self Management course was taught by presenter Mary Wall, also with another faculty member.

The faculty were identified ten months before the pilot began. That time was devoted to preparing the syllabus, course activities, and evaluation. Every effort was made to incorporate collaborative learning activities in the classes. The resulting materials were extensive and detailed.

This presentation will deal with the successes of the pilot courses, and the difficulties encountered. Successes included student response, course design, and enthusiasm of the student and teachers in the pilot. Difficulties included problems with the hardware and software, the time involved in developing the courses to use the new technology, and initial adjustments that had to be made in learning in a new environment.

PROBE

Student evaluations were conducted at the end of both classes and will be shared at the conference. Reports were written by the teachers of the pilot classes, with recommendations for improvement.

In Spring 1997, Introduction to Literature was offered in the synchronous classroom, and Communications 1, Communications 2, and Special Topics in Literature were offered in the asynchronous mode.

SUMMARY

While distance education is in keeping with the mission of the community college, it involves a major shift in the allocation of resources. The entire college must be involved in the effort: the Information Technology area, the faculty, the administration, and the counseling office. Only by involving the entire college community can the effort succeed.

We were happy we began with elective pilot courses. Students in these courses were mature adults, who could adapt to initial problems with hardware and software. The faculty selected were experienced teachers, who had many years of teaching at the college and were willing to take chances.

Evaluation formed the closing of the cycle. As distance education becomes more common at the college, the lessons learned in the initial pilot will be routinely incorporated into the process. In this session we would like to share with others considering distance education the model that we used and the lessons that we learned.

The TEAM Project: A University - Public School Collaborative

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Abstract: The TEAM Project employs Appalachian State University faculty and graduate students to support teachers in a seven county Partnership as they integrate computer technology into their daily classroom activities. The TEAM Project provides hands-on workshops for teachers from 85 schools, Internet connectivity, free access to e-mail on the university mainframe computer to the 2,500 teachers in the Partnership, model teaching, and graduate students in computer technology who work one day a week for one semester in a school. The Project has evolved from an emphasis on large group training to an emphasis on in depth training for smaller numbers of teachers.

The TEAM Project at Appalachian State University in Boone, North Carolina, is in its fourth year of planning and executing staff development in computer technology and its integration in the classroom. The Project serves teachers from a seven county area comprising the Appalachian State University/Public School Partnership. During the first three semesters, the focus was teaching telecommunications, databases, and spreadsheets to large groups of teachers in each of the Partnership counties. However, beginning with the 1995 fall semester, the approach changed to targeting a small number of teachers and working in depth on telecommunications applications for both classroom use and for professional development.

Technology Contact People

Each of the 85 schools in the Partnership has designated a technology contact person for TEAM. This person is a classroom teacher rather than a computer technology specialist. The technology contact person's responsibilities are to attend three five hour workshops at Appalachian State University, to develop and execute lesson plans incorporating computer technology into their teaching, and to visit the TEAM homepage each week in order to disseminate relevant teaching information to co-workers. TEAM awards each teacher a stipend of $100 per workshop.

All workshops accommodate teachers with various levels of computer skills. The first workshop focuses on the use of electronic mail. Novices learn such activities as logging on, accessing and sending mail, and creating an address book. More advanced users learn how to append and access attachments to e-mail. The first workshop also includes guided practice in navigating the Internet including bookmarking, using search engines, and printing. The second workshop highlights using the Internet to access sites which can be used in each teacher's current curriculum area. Round table discussions provide a forum for teachers to share ideas about using computer technology in the classroom. The third session provides guided time for each teacher to prepare a lesson using Internet resources. A culminating activity allows teachers to share with each other the lessons they have designed.

Continuing Support

The TEAM Project continues a relationship with the technology contact people by sending them weekly electronic messages encouraging them as they incorporate the computer into their teaching and inviting them to share creative ideas on a wide variety of subject areas. The technology contact people as well as other teachers in the Partnership have the opportunity to join a listserv to which they are invited to pose questions, list helpful websites, and post calls for collaboration.

During the 1997 spring semester, TEAM is sponsoring two collaborative endeavors. The first is a weather project to which each participating classroom sends information about area weather conditions at specific times of the day. Those data are compiled and posted on the TEAM webpage. A second project involves students' submitting information about their community including a description of the community along with a brief history told to the students by an elderly citizen.

Other Workshops

Team offers special interest workshops for teachers. Website construction has enabled a number of schools to produce vanity pages on the Reich College of Education fileserver. TEAM also conducts introductory and advanced workshops on installing and navigating Windows 95. Additional workshops provide instruction to public school principals, superintendents of the Partnership counties, and administrative assistants from each central office. Each workshop is tailored to the specific needs of the group to facilitate communication between people of like responsibilities and to identify resources available to administrators.

Connectivity

In 1994, the project offered toll free access to Appalachian State University's mainframe computer for 2,500 school personnel. That connectivity gave them access to all the distance resources available to the university. As teachers requested graphics rather than text only and as TEAM's toll charges began to increase with the expanding teacher use, TEAM funded Internet access through local providers. Funds were available for connection for only four schools in each county. Negotiations with local providers resulted in their offering free service to schools in four of the seven Partnership counties. TEAM then purchased connectivity with local providers for all of the schools in the remaining three counties for one semester. At the end of that time, each school's personnel evaluated their use of the service and decided whether or not to pay for connection themselves. Then the toll free 800 access to the university's computer system ended.

TEAM maintains a website that is updated weekly. A new "Link of the Week" appears each Monday. These links are chosen because of the sites' potential for use in the classroom. Data from collaborative projects are posted on the page as well as links to course offerings in technology for teachers by local community colleges. In addition, the site provides administrative resources and links to lesson plans for a variety of subjects..

Internships in Schools

Technology Coordinators in each of the seven school systems choose one school to host a graduate student in computer technology to work in that school one day a week. The main component of the graduate students' duties is working with teachers to plan lessons integrating computer technology in their curriculum. The students help locate resources for the teachers, co-teach the lesson, model teach the lesson for the teachers, or trouble shoot technical problems that may arise while the teacher is conducting the lesson. The graduate students also work with teachers individually or collectively to teach button pushing skills or develop collaborate teaching units. The sustained presence of the graduate students throughout a semester has enhanced and expanded the use of computer technology by both teachers and students.

Lessons for Staff Development

The TEAM Project has found that planning for staff development that results in teachers using computers effectively and comfortably in their teaching must incorportate the following three areas. The first area is the number of participants in each staff development session. A series of workshops with no more than 15-17 teachers provides participants sufficient technical and integration skills to use computers consistently and effectively in their classroom. Workshops with a larger number of participants often do not provide enough individual attention for teachers to carry the learning into effective teaching practices. The second area is sustained contact with teachers after staff development workshops. For the first three semesters, TEAM maintained a toll free help desk for teachers with questions. On-site help, however, has proven to result in greater teacher satisfaction. Graduate interns in the schools have been a key to substantial qualitative and quantitative use of computers. The final area is providing collaborative opportunities for teachers. Collaboration between teachers at the computer as well as collaborative projects for students has increased the enthusiasm and comfort level of educators as they use computers in their teaching. The TEAM Project continues to evolve in its approach to designing staff development. Its primary commitment, however, is support for teachers that results in enhanced learning opportunities for students.

An ITS for Guiding Fraction Calculation using a Pen-Computer
– Handwriting Character Input Interface and Its Evaluation –

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Abstract: This paper describes an implementation of an ITS for guiding fraction calculation using a pen-computer and evaluation of its interface. By using a pen-computer, our system has following distinctive features; (1) handwriting character input with its recognition, (2) direct pointing and (3) gesture function for fraction correction. The handwriting character input with its recognition using a pen enables students write fractions easily and naturally as if to use a pencil. The direct pointing function enables students fix input point without moving a cursor. The gesture function contributes easy fraction correction. The results of evaluation experiment show these distinctive features work well.

1 Introduction

We have developed an ITS for guiding fraction calculation. This is a drill type ITS. Distinctive features of the system are that it can recognize student's context of solving processes and guide them in accordance with their context [Watanabe, 1994].

Recently, there are a lot of products that make use of a handwriting character recognition and liquid crystal technologies such as a pen-computer. We have made use of advantages of a pen-computer to our system as an interface. This new system has following distinctive features; (1) handwriting character input with its recognition, (2) direct pointing and (3) gesture function for fraction correction.

This paper describes an implementation of an ITS for guiding fraction calculation with handwriting character input interface and its evaluation.

2 Outline of the system

The system is implemented on two computers. One is a pen-computer (SANYO MBC-MP100J), the other is UNIX workstation (Sun SPARC station 5). The pen-computer plays a role as an interface. The UNIX workstation has intelligent modules. These two computers work together.

3 The interface

[Figure 1] shows the display of the interface. A student can write fractions using a pen into the input field which is presented in the left side of the display. When a student writes numerical characters and other symbols such as '+' and '−,' the system starts to recognize the character. If the system succeeds in recognition, recognized character is shown in the same place. If the recognition fails, the system erases the handwriting. So the student has to write character again.

The system has two special functions for fraction correction. One is "overwriting," the other is "gesture function." The overwriting function replaces a character on the display. We define some special handwriting symbols as "gesture." When a student writes a gesture, the system executes a function bound with the gesture. The system has two types of gesture, "erase one character," and "erase whole fraction expression."

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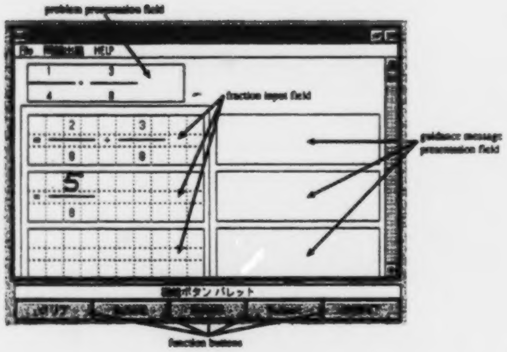
problem presentation field
HELP
fraction input field
guidance message presentation field
ボタン パレット
function buttons

Figure 1: The interface

4 Evaluation of the interface

We had an experiment to evaluate the fraction input and correction of the pen-computer system. In the experiment, students tested three systems (1) the pen-computer system, (2) the keyboard system and (3) the pencil and notebook. Amounted 38 students joined the experiment. After using all systems, students answered to a questionnaire.

74% students felt better the pen-computer system than the keyboard system for fraction input operations. Advantages of handwriting character input with its recognition and direct pointing function reflected the result.

Although students used the same medium at using the pen-computer system and the pencil and notebook, 79% students felt better the pencil and notebook than the pen-computer system for fraction writing. We think that there are two reasons, both of them are technically solvable. We are going on an improvement. These problems will be solved in the near future.

76% students felt better the pen-computer system than the pencil and notebook for fraction correction. Because the system doesn't need to use an eraser. This advantage enables students to correct easily and quickly.

On the keyboard system, students have to move a cursor to the point where they want to correct. However, the pen-computer system doesn't require these efforts to the contrary. 79% students felts better the pen-computer system than the keyboard system. The result shows this advantage. The gesture function is also work effectively. It contributed easy fraction correction. A lot of students commented on it.

5 Conclusion

We have developed an ITS for guiding fraction calculation using a pen-computer. This system has following distinctive features; (1) handwriting character input with its recognition, (2) direct pointing and (3) gesture function for fraction correction to the system. The results of evaluation experiment show these distinctive features work well.

We are going on an improvement. We are planning a field test of the pen-computer system. These are future issues.

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A Multimedia Database Authoring System as Archives for an Entire Field of Study

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Concept of the Project MILES

The multimedia database system MILES (= *M*ultimediales *I*nformations- und *LE*hr*S*ystem), the first of its kind in Europe, has been developed in the Department of Physiology, University of Essen Medical School, in two stages since 1980 [Wiemer et al. 1989, Wiemer 1997]. The field test of the PC-version began in 1989/91 in connection with teaching physiology to 160 students of medicine per year. Since 1993, MILES has been employed in all types of classes as well as in individual studies independent of classes. By the beginning of 1998, most of the curriculum subject matter provided by the department will be covered by the system. The primary aim of this project is not to produce single teaching units, such as particular simulations or tutorials, but to use this system as a *common source for all computer and audiovisual materials* over the entire curriculum in physiology.

Configuration: The *hardware* consists of a network of personal computers (386/486 compatible, SVGA 1024 x 768, operating system PC-DOS), supported by servers, and connected to various input/output and storage devices. The *software* is built around a text processing *database*, containing all text sections of documents as well as the control information about all non-text materials in store. The user also possesses a *personal base*, to which data and program references can be transferred from the main system by a standard command; thus students can build up data collections and learning programs of their own.

Materials: Up to now, more than 9000 documents have been stored including data processing programs, simulations, signal recordings, video and audio modules, about 3000 pictures, a glossary of physiology with several hundred entries, and a collection of more than 3000 test questions. Only part of this material was produced in the institute, the rest acquired from external sources.

Teaching units. The units compiled from these components are structured differently, depending on their curricular affiliation (lecture, seminar or practical) and level of comprehensiveness required by their contents (for example, whether they treat new topics, or present just supplements to matters generally available from text books). Altogether, the system provides materials for the following main applications: a) *demonstration in lectures and seminars,* b) *work in seminars and practicals,* c) *individual studies independent of classes* at terminals in the institute, d) *studies at home,* for which units will be offered from 1997 on.

Experiences and Problems

System performance: Our expectations in regard to power, versatility, flexibility and portability of such "open" multimedia systems have been fully confirmed, the teaching concept has proven realizable. Current problems no longer arise from hardware, but from *software,* from *application concepts,* and from *production of teaching material.*

Acceptance by students: MILES has been accepted by students well, and was, in part, rated even higher than the accompanying personal teaching. However in practice, this positive attitude held true only as far as computer-based materials had been presented in seminars and practicals, that is, *had been integrated in personal teaching,* *and contained obligatory subject matter* examined thereafter. Only here our students made intensive use of system materials. There was significantly less interest for materials from lectures, which are neither obligatory nor connected with examinations. The acceptance was extremely poor for materials offered *in bypass to classes as mere self education programs.* The majority of students considered these new media altogether as *very useful, but not necessary,* i. e. lastly as a superimposed teaching, not professionally required, technology.

Concepts for future application of multimedia systems in medicine: These are still controversial, ranging from mainly computer-mediated curricula to merely focal integration into traditional teaching and learning. Since *direct experience with patients under the guidance of personal teaching will remain indispensable,* "virtual" medical schools are certainly unrealistic. Thus, *integration into* - however changed, but further existing - *personal teaching and into books appears to be adequate for the new media in medicine.* The domains may be expected to be a) *databases,* also providing general availability of pictures, films and signal recordings, and furnishing components for local composition of teachware, b) *simulations* of biological functions, of skills and practices, and of diagnostic procedures, using increasingly interactive video and CAD-techniques, c) *tools* for acquisition and processing of data of all kinds, d) *test materials* for evaluation of knowledge and skills, utilizing also multimedia techniques, e) *"open" authoring systems* for the local composition or adaptation of demonstration and teaching units, f) *tutorials,* for which, however, we see in view of good text books no exhaustive need.

The production problem: The most severe handicap for the broad introduction of computer media into teaching and learning in physiology proved to be the general *lack of materials,* especially those meeting high academic standards - not only of proper programs (such as tools, simulations), but also of components (such as bases of picture and film collections on disks) suitable for building up individual teaching units. Offers *on the market* are still minimal. On the other hand, possibilities of *individual staff members* for the production of good teaching material are very limited, due to the high expenditure of expert time and technical know-how. Especially detrimental is the present *copyright situation.* The lack of a general copyright for acquisition and transfer of educational material by electronic media prevents the exchange between institutes of material collected individually from commercial sources, such as figures from scientific literature, or films. As a consequence, systems like MILES are, at present, *not transferable,* since most materials cannot be transferred along with the software.

Acceptance of the new media by the academic staff: This is, on the whole, still unsatisfactory. Typically, just the prominent scientists do not participate in the production of media, at best they write text books. The situation is especially crucial for the junior staff, since in university systems as the German, academic career depends on merits of research, not of teaching. Consequently, there is a discrepancy, typical for the situation, between impressive reports on symposia and conferences about progress of system performances, and lack of use on the teaching level. Improvement can be expected only from the establishment of *broad systematic production of material* in co-operation between groups of authors, institutions, and commercial producers. So it may last another decade until the new media - already proclaimed overall victorious - will really have conquered higher education in medicine.

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Teaching a Graduate Program Using Computer Mediated Conferencing Software: Some Reflections

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Abstract: This presentation describes the authors' experiences developing and teaching the first two computer mediated courses in an innovative Master of Continuing Education program at the University of Calgary in Alberta, Canada. Each course included: pre-session readings and orientation assignments, explicit learning goals and objectives derived from both students and overall program goals, systematic weekly agendas, interactive assignments, learning journals, small virtual group and/or dyadic exercises, flexible assignments, and on-line access to library resources. The instructional plan was organized around fulfilling four moderator functions: pedagogical, social, managerial, and technical (Berge, 1995). This paper focuses on how the authors' experiences with CMC did not always coincide with the oft-cited benefits and challenges of teaching in this medium described in the research literature. The authors feel that the partnership of computer technology and adult education has tremendous potential for re-conceptualizing the roles of instructor and student only if a significant investment is given to it by all stakeholders: instructors, students, technical support staff and program administrators.

The Benefits and Challenges of Teaching via CMC

In the relatively short time that computer mediated teaching has been available, several studies and literature reviews have pointed to a number of benefits and challenges of this mode of teaching (Burge, 1994; Gerein, 1995; Harasim, 1987; Hiltz, 1990; McCreary & Van Duren, 1987). The authors' experiences with teaching two pilot CMC courses in a new graduate program did not always coincide with these cited benefits and challenges in particular: higher level of participant interaction; higher quality of learning; access to more resources; technical difficulties; time-committment required by all participants; and miscommunication.

Reflections on the Benefits

A higher level of participant interaction, or interactive 'dialogue', did not always materialize. Many students reported a sense of 'monologue' instead of 'dialogue' and frustration with a lack of connectedness to classmates.

While the quality of learning did not suffer, CMC did not appear to afford as high a quality of learning than that experienced by both instructors in comparable face-to-face learning environments. However, the non-synchronous, text-based nature of CMC appeared to benefit less assertive/more reflective students (particularly female) who responded positively to the increased time to think and edit their on-line contributions.

CMC does allow for more access to a variety of library and internet resource. Not all studnets had the necessary time or technical expertise to take advantage of this feature.

Reflections on the Challenges

The technical difficulties encountered, which far exceeded both instructors' and students' expectations, were exacerbated by totally inadequate technical support.

CMC, as a text-based medium, required a far greater time-committment by both instructors and students. This unexpected additional time requirement was a major source of frustration and conflict for many.

Learning to communicate effectively without benefit of visual/auditory cues was particularly challenging for novice CMC participants, often resulting in still additional on-line time to clarify misunderstandings.

Conclusions Reached

Overall, these instructors found that one key distinguishing factor of quality face-to-face and on-line teaching, was a dramatic shift from a traditionally instructor-centered and authoritarian classroom towards a more student-centered, collaborative and egalitarian learning environment.

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VIRTUAL GORILLA PROJECT "GORILLAS IN THE BITS"

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Abstract: The Virtual Gorilla is an immersive educational tool to aid in the instruction of K-12 grade students in the understanding and appreciation of animal behavior and issues of animal conservation. Through this immersive technology children can "be a gorilla," and experience "first-hand" what it is like to join a gorilla family group. VR technology has the potential to be a powerful tool in experiential education, in this example, sensitizing children to the gorilla world and giving them an understanding of the behavioral interactions that create gorilla society.

The Virtual Gorilla is an educational tool being developed by researchers from the Georgia Institute of Technology's Graphics, Visualization and Usability (GVU) Lab and PhD program in the College of Architecture in conjunction with researchers and staff from Zoo Atlanta. As a part of established Zoo Atlanta conservation efforts, the Virtual Gorilla project is being developed as an immersive education tool to aid in the instruction of K-12 grade students in the understanding and appreciation of animal behavior and issues of animal conservation.

The VR gorilla environment allows us to extend the educational experiences provided in the traditional zoo environment. A primary goal of Zoo Atlanta is to increase public awareness and involvement with issues of conservation. Through this immersive technology children can "be a gorilla," and experience "first-hand" what it is like to join a gorilla family group. They can "test" behaviors and elicit appropriate responses from other members of the gorilla family. We have been working with Zoo Atlanta staff not only to provide a realistic representation of the gorilla and the exhibit habitat, but to realistically portray the behavioral actions and reactions of the family group members, including motor behaviors and vocalizations. We expect this will be a powerful experiential educational tool in sensitizing children to the

Research on effective learning experiences suggests that this participatory environment will enhance and reinforce children's learning [see Bosco 1986; Fletcher 1989, 1990; Stafford 1990; Verano 1987]. Participatory experiences have been shown to increase motivation and retention of information. Entering the gorilla world captures a child's attention. Participation brings involvement and motivation to explore. This opportunity to "role play" provides each child with his/her own individual experience, one that is tailored to the interests and experience of the particular child, and one that may be different each time the child participates. This freedom to create a unique zoo experience, contributes an element of the unexpected, again an enhancement to learning.

The VR Gorilla Exhibit is a Virtual Reality representation of a real Gorilla Exhibit at Zoo Atlanta. Data provided by Zoo Atlanta includes actual terrain elevations, texture maps of foliage, and blueprints and site measurements of architectural structures. The modeled environment consists of the four main gorilla habitats, two auxiliary habitats, visitor pathways, exhibit areas, as well as the night holding facilities of the gorillas. Georgia Tech's Simple Virtual Environment (SVE) Toolkit is used to create an interactive, real-time virtual environment for exploration and learning.

The virtual gorillas are modeled based on anthropomorphic data from Zoo Atlanta. The gorilla model currently consists of 10 body parts and 9 joints with a total of 20 degrees of freedom. Motions are keyframed. The keyframes are generated from video of actual gorillas at Zoo Atlanta, and from behavioral data of gorilla movements. Keyframes currently illustrate characteristic locomotion modes and stances, such as walking on four or three legs, standing, squatting, lying down, staring aggressively, and chest-beating.

Gorilla behavioral data is derived from field notes and documentation gathered by Zoo Atlanta Researchers. This data was used in conjunction with expert advice from the zoo researchers who detailed behaviorial actions and reactions. (Some times even re-enacting the behavior on site, for Georgia Tech researchers!)

Currently users assume the identity of a juvenile gorilla within the simulated family. Beginning in the gorilla observation pavilion, the user become familiar with their environment and means of locomotion (currently gaze directed, frontwards and backwards movement). Once comfortable within the environment, the user will then pass `through the glass' and into the gorilla environment. Once on the gorilla yard, the user is restricted in movement only to that of the real gorillas at Zoo Atlanta (single yard, only terrestrial movement, though they can `climb' in and out of the moats separating the yards). The user may to explore the moats, rocks and trees, or attempt to interact with the other family members roaming the yard. The manner in which they approach the other members of the family group is monitored and appropriate response behaviors are elicited from other members of the family group.

Further development of the project will include expanding the behavioral repertoire of the animals to create a more realistic representation of the complexity of the gorilla society. A recurrent comment from the children who were involved in the demo was their interest in having a 'child' gorilla to interact with. This is one of our priorities for further development. The advantage of a young gorilla is that they tend to display a more varied and playful array of behaviors. The older gorillas are not very active. Although this is realistic, the kids entering the gorilla world are looking for more action. A young gorilla would provide this activity.

As the project is updated we will continue to work with groups of middle school students and their teachers to obtain feedback as to its potential effectiveness as a learning tool. This immersive environment will also be developed as a tool for zoo visitors to have an opportunity for a behind-the-scenes looks at the gorilla facilities. Visitors will be able to explore areas of the gorilla domain, such as the night quarters, that are ordinarily off limits. Explanatory information will be provided, as well as interfaces to access further information about the different care, conservation and research activities of Zoo Atlanta.

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A Multimedia, Professional Development Program in Technology Enhanced Instruction

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Abstract: The rapid influx of technology into education has increased demands for effective professional development in the use of new learning technologies in the classroom. This paper describes a CD-ROM based, professional development model designed to guide teachers in the effective classroom implementation of Technology Enhanced Instruction (TEI). The model is based upon the results of a four year field study of technology implementation in secondary science classrooms and includes exemplars of successful TEI teaching and learning strategies.

Background to Model Development

Technology Enhanced Instruction (TEI) is instruction in which computers, multimedia technology, telecommunications, and related resources are used to aid student learning and access to information. The TEI Professional Development Program described in this paper emerged from a longitudinal research program called TESSI (Technology Enhanced Secondary Science Instruction) [Woodrow, Mayer-Smith and Pedretti, 1996]. TESSI was designed to systematically integrate computers, multimedia technology, and related resources with elements of exemplary instructional practice to create a model of Technology Enhanced Instruction for science education. In each of the last four years, TESSI has produced increased learning outcomes and more positive student attitudes towards science and technology, and is in a unique position to guide teachers in effective classroom uses of technology.

Objective and Rationale

The objective of the TEI Professional Development Program is to help teachers learn to implement successful TEI teaching and learning strategies. [Gunter and Murphy, 1995] suggest that a major reason that education has been slow in implementing TEI is that "teachers have been involved in insufficient professional development/inservice activities regarding effective classroom usage of technology". How does a teacher learn to become an expert with TEI? Most technology training programs for teachers are aimed Level I Training: the development of foundation computer-use skills. While such training is necessary, it is not sufficient. Too often, upon the completion of training sessions, teachers are left on their own to figure out how to use new skills to enhance learning; no provision is made to address the fact that innovative and effective classroom uses of technology require revisions of teachers' and learners' educational practices. As computers and information technology become more fully integrated into classroom practice, teachers shift from whole-class instruction toward small group tutoring [Collins, 1991]. These changes occur because the technology takes over some of the traditional "information presenter" role of teachers, allowing teachers to interact in new and more effective ways with their students. Collins also indicates that the role of the student changes. Students become more engaged, learn at their own rates, and become collaborative as opposed to competitive.

Method

TESSI's TEI Professional Development Program is based upon the premise that, in addition to basic computer skills, teachers need meaningful exemplars of how technology can be used to enhance teaching and learning. One-day workshops are typically not effective in promoting enduring changes in teaching practice. Multi-day summer institutes may be more effective but they tend to be expensive to run and serve only a small percentage of teachers. Neither format provides the ongoing professional development opportunities and support for teachers that [Fullan, 1991] identifies as necessary for successful school-based innovations, nor the opportunity for practicing new skills in the classroom and reflecting on the results. The TEI Professional Development Program is based upon an alternate training model - that of a stand alone, interactive, multimedia program designed by teachers for teachers.

TESSI's TEI Professional Development Program is based primarily upon the experience TESSI teachers have had implementing TEI into Physics 11 and 12, and helping other teachers to implement TEI strategies. The Program draws upon an established research base, extensive teacher experience and documented results to generate an effective means of assisting teachers in negotiating the complexities associated with learning to implement TEI. The CD-ROM based program was developed using Authorware™ Professional on a Macintosh 8500 computer for both Macintosh and Windows platforms. Video segments include professionally recorded footage prepared for a province-wide video conference by British Columbia's Open Learning Agency. The CD-ROM format was selected to offer "just-in-time" practical knowledge when and where it is needed.

Incorporating text, sound, digitized images and video, the TEI Professional Development Program features:

- teachers describing and illustrating the structure and operation of a TEI classroom using both still images and video clips of TESSI classrooms.
- teachers introducing and providing exemplars of teaching and learning strategies that are effective in TEI classrooms.
- teacher and student perspectives on teaching and learning in a technology enhanced science classroom including their views on their roles.
- interviews with students, teachers and administrators about the essential outcomes of implementing TEI.
- teacher responses to frequently asked questions about TEI.
- lists, discussions and demonstrations of basic equipment and software.
- software tutorials.
- hard to locate technical information about setting up and maintaining a computer-integrated classroom.
- a teacher annotated bibliography of articles related to TEI implementation and research.

Educational Significance of the TEI Professional Development Program

The TEI Professional Development Program can be expected to have a significant impact on the further development of educational practice because it so directly addresses an essential educational need - training in the effective use of technology in the classroom for teachers, by teachers. The program promises to deliver inservice and preservice TEI training in an efficient, functional and cost-effective manner. The final program can be made available to individual teachers either as a CD-ROM or, eventually, on-line.

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Hypertext Sexual Harassment Web Page

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Abstract: This paper describes a hypertext web page on sexual harassment designed as one component of a gender and communication class at the Delaware County Campus of Penn State University. We explain the rationale for the choice of hypertext and describe how we designed and used the program. Finally, we evaluate the use of hypertext as a classroom pedagogy and provide suggestions for improvement. The web page address is www.de.psu.edu/harass/intro.htm.

Rationale for Using Hypertext

Sexual harassment is a very complex issue. Scholars, legal experts, and ordinary people struggle to define and characterize sexual harassment and to devise ways of preventing or dealing with the problem. Teaching about sexual harassment is also complex. No single pedagogy can provide a comprehensive treatment of sexual harassment. Group discussion allows for exploration of a variety of perspectives in an interactive forum, but good group discussion must be based on some shared understanding of theoretical concepts. Traditionally, these concepts have been introduced to students in lectures or reading assignments. Both lectures and text share the problem that ideas must be presented sequentially, making it difficult for listeners/readers to connect ideas from different sections of the lecture or of the book. Furthermore, it is difficult to convey effectively the complex emotional and psychological aspects of sexual harassment in linear texts. Finally, both lecture and text privilege the "voice" of the instructor as the expert instead of empowering the students to learn from their own experiences and to connect classroom learning to their professional and personal lives.

Hypertext can provide theoretical concepts, differing perspectives, and case studies on which to base group discussion of sexual harassment issues. Hypertext "decenters" the text and allows readers to structure the material in ways that make sense to them. Hypertext can provide links to external websites, situating the information in a wider context of "real life" experience.

Design and Use of the Hypertext Sexual Harassment Web Page

We set the following learning goals for students:

- to define sexual harassment
- to recognize behaviors that may constitute sexual harassment
- to know their legal rights and appropriate procedures if they are harassed
- to avoid acting in ways that might be interpreted as sexual harassment
- to explain sexual harassment to other people.

We collaborated with the Affirmative Action Office of Penn State University in designing the hypertext web page. We envisioned a program that would provide both legal and theoretical analyses of sexual harassment, supplemented by case studies and connections with other web pages and suggested reading. We also wanted

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students to become familiar with Penn State's procedures for dealing with sexual harassment. The web page was organized into these six areas of information:

- Legal Definitions
- Theory and Analysis
- Cases
- Related Web Sites
- Bibliography
- Penn State Policies and Procedures

Students could begin in any one of these areas and follow links to move easily from one section to another. Students kept a log of their responses to the web pages as they worked their way through these six areas. We found that they did indeed take individualized paths through the material. The logs also revealed a wide variety of responses to and interpretations of the material.

Evaluation of Hypertext as Pedagogy

In designing the web page we worked closely with colleagues within and outside Penn State to locate appropriate resources and to create a web page responsive to the needs of a readership wider than the class itself. Such consultation is rarely called for when we rely on lecture as a primary pedagogy. The ability and necessity to link different aspects of the material through both logical and psychological connections was challenging, as we attempted to represent the complexity of the issues associated with sexual harassment. Designing the links among documents required us to keep in mind the needs and interests of our potential readers to anticipate the ways in which they might structure their reading. In that sense, the act of writing in hypertext established a stronger sense of connection with a wider set of potential readers than has the act of writing lectures or papers. We developed a much deeper understanding of sexual harassment and the multidisciplinary complexity of this topic than we might otherwise have done with a traditional pedagogy.

The logs kept by students as they read through the web page revealed that they forged a variety of paths through the material and developed differing perspectives on the material. We believe that links to web sites with related information provided a context in which the academic assignment clearly related to problems and programs in the larger world. Proponents claim that multiple paths through a hypertext empower students to read creatively, but we note that these multiple paths may also allow readers to avoid engaging perspectives different from their own to a greater degree than with a traditional text. Students reported that they enjoyed this assignment. The question of whether or not students developed an increased understanding and appreciation for the complexity of sexual harassment remains to be determined.

Writing in hypertext necessitated careful attention to the appearance of the text on the page, because the appearance of text on a computer screen is crucial to its success. We enjoyed designing beautiful pages, a reward unavailable in writing lectures or papers. In fact, most of the many positive responses to our web page have been editorial and not substantive. To the extent that browsing web pages partakes of entertainment and not of serious academic pursuit, use of this pedagogy may be problematic.

Future Uses of Hypertext as Pedagogy

Since we found the process of writing hypertext to be so fruitful, in the future we will incorporate student involvement in the design and production of the web page. Students will gather information from a variety of perspectives for inclusion in the web page; in this way they will be unable to avoid dealing with the controversial issues implicit in the topic. When students themselves must design the links among the document in the web page as well as the links to other web sites, they should develop a more complex understanding of the issues implicit in the topic. We also hope that this process will help students begin to understand the basic communicative processes that are involved in sharing information. We hope that students will learn to think carefully about the potential users of a web page and understand the psychological as well as the logical processes necessary to share information.

A Computer-Assisted Multimedia Language Testing Program: Chinese Computerized Adaptive Listening Test

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Abstract: The Chinese Computerized Adaptive Listening Test (CCALT) is designed for testing Chinese listening proficiency. The target audience include the high school and college students who study Chinese as a second language. In this project, the computer is used to estimate the student's knowledge level, generate test items, present the item in the context, and record the testing data. The current item bank consists of over 350 items, and about one-third have been tested on 60 target students. Re-calibration of the items was done based on the testing results. The results also indicated that the CCALT tends to enhance the student's motivation and reduce test anxiety.

Computer and Foreign Language Instruction

To be proficient in a foreign language means to use the language in contexts and carry functions in the target culture [Omaggio, 1986]. Therefore, to present the language in authentic culture and contexts is critical in foreign language instruction. Video discs and CD-ROM's are ideal for this purpose. They can provide dynamics (motion pictures) and play high-fidelity still frames and audio. They are also more flexible in terms of providing fast random access to specific video segments [Altman, 1989]. Controlled by a computer, video disc and CD-ROM programs are more interactive than linear videos and other traditional media.

Many commercial computer-assisted language materials include exercises and tests, however, the format and items of these tests are less formal than computer-assisted language testing (CALT). In CALT, the computer is not only used to elicit and assess a student's language performance, it also offers stimuli and realistic contexts. The CALT can produce interactive, tailored tests where the test adaptive itself to the student's knowledge level [Noijons, 1994].

Computerized Adaptive Testing

Computers have been used for item generation and scoring objective tests. Modern research focuses more on computers' capability of interacting with the student. They can register the time the student spent on the item and the route of the student's through the test, estimate the student's level and select appropriate items. This feature is highly related to adaptive testing. A computerized adaptive test usually works this way: the computer first assesses the student's knowledge by giving a preliminary test which leads to an estimate of his or her level, then it searches the database for an item at the level and administers it. If the student responds correctly, the system adjusts its estimate upward. If his or her response is incorrect, the system adjusts its estimate downward [Alessi & Trollip, 1991]. It will eventually stop administering items when the level of the student is identified and the estimate becomes reliable.

The Chinese Computerized Adaptive Listening Test (CCALT)

In light of the research findings on computerized adaptive testing and the use of computer-assisted programs in foreign language instruction, I and my colleague began to develop the Chinese Computerized Adaptive Listening Test in 1994. The target students are the high school students and college students in the United States. who study Chinese as a second language. Currently the item bank consists more than 350 items. The items were inter-rated by Chinese listening test experts based on the ACTFL (American Council on the Teaching of Foreign Languages) Guidelines on listening proficiency [ACTFL Guidelines, 1987].

The test begins with a page collecting demographic data (the student's name and ID, and years of studying Chinese). Then a preliminary test is administered to obtain an estimate of the student's proficiency level. Based on the estimate, the computer routes the student to the appropriate item level and administers a question to him or her. The system then administers another item at the level or moves downward or upward depending on the student's response. The test stops when the student's proficiency level is identified. Data including time on each item, time on the test, and the student's answers are recorded.

Each item is presented through a movie clip (dialog/speech accompanied by dynamics) or a sound clip (dialog/speech) accompanied by a picture. A multiple-choice question with four options is displayed on the computer monitor after the audio finishes playing. The student clicks on an option to answer the question, then the computer takes him or her to the next item.

About one-third of the items belonging to the Novice Low through Advance levels were tested on 60 target students. A preliminary study of the online data and the students' responses to the questionnaire revealed that the correlation between the student's performance in the CCALT and in a traditional listening proficiency test is relatively high. The computer-assisted multimedia format made students less nervous than the traditional paper-and-pencil tests. Some students commented that the contexts / visual cues helped them understand more of the content, and made more sense than traditional test. The study was used to re-calibrate the items. Some items were moved to a different level, and some questions were re-written.

Technical and testing issues need to be addressed in the next stage of the development of the CCALT. Specifically, we will work on these aspects: First, the most challenging tasks are calibration of the current items and reliability study of the test. Each item will be exposed to one hundred targeted students. The results will be used for psychometric calculations (difficulty indices) and adjusting the algorithms. Further study will investigate the correlation between the CCALT and traditional proficiency listening test. Secondly, the sound embedded in the movie is not as high quality as the sound played with a picture, because the compressed movie occasionally produces frame drop-outs when being played back. Some movie clips will be re-compressed with newer technology. Thirdly, an effective delivering method needs to identified. Should it be delivered from a CD-ROM or through LAN? What are trade-offs of using either method?

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POSTER/DEMONSTRATIONS

Strategies Instruction: Mathematics Problem Solving using Computer Based Instruction

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Enhancing students' problem solving skills in mathematics has been a major concern of educators over the years. This might be resolved by combining cognitive and metacognitive strategies instruction. Some researchers suggested that computers can be used to teach problem solving skills explicitly and improve learning processes. This is, because computers provide students with a friendly means which presents computer graphics, movement of figures, and immediate feedback. Combining computer based instruction with structured teaching can be a powerful supplement to classroom instruction. Therefore, a Computer Based Instruction (CBI) program was developed to explore the potential of using this means to teach grade six students problem solving skills in mathematics problem solving. A general strategy, SPIDER was developed and embedded to facilitate students' mathematics problem solving performance by cueing them in the major components in mathematics problem solving.

A Multimedia Application to Teach First Year College Calculus

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This multimedia contains mathematical subjects of a first year Calculus course in Engineering.

Subjects correspond to the chapters of a book: foundations, real numbers, numerical sequences, limits, differential calculus, integral calculus, ordinary differential equations.

Each subject is organised in four **Areas**: Theory, Practice, Investigation, Indexes.

The Theory area contains: definitions, theorems, exam questions. Similarly, in the Practice area, users meet: examples, exercises, exam questions; while in the Investigation area they find epistemological unfoldings and historical investigations. The Index area gives students a general view of all algorithms and numerical tables.

A specific mathematical software allows users to answer questions and compare their results with installed solutions.

The Investigation area shall be completed for the final edition of Mediamath, expected next year.

Mediamath is intended for an MS-WINDOWS based Pc. The final product shall be installed in both Stand-alone and Client-Server versions; it will be masterized on CD-ROM.

Knowledge-Based Medical Training Systems

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Two based on the expert knowledge training systems are described. The first of them is associated with investigations of histological preparations, the second one is assigned to. the electrophysiology area and designated to determine evoked potentials on electroencephalograms. When exploring the preparates, the construction of *associative image series* [see Granovskaya and Bereznaya, 91] was used as the main training method. By this series we mean the sequence of images, each of them is the coded input image and depicts some information sign. Solving our problem we coded this sign by color according to some scale. So, we impose the input preparation image and two coded pictures together. Simultaneous presentation of all images allows to originate the associative series with desired directionality. Computer processing of EP has traditionally followed two basic methods: using Fourier transform and the structural approach to curve processing [see Kulanchev and Kaplan, 94]. We have developed the method [see Ampilova and Strakhovich &amp; Ampilova, Grachev and Strakhovich, 95], based on using by expert of revealable features. The models were implemented on IBM PC. As input data we used the cipher signals and images, obtained at output of traditional medical equipment.

Using Multimedia for Promotional Purposes in Education: A Multimedia Presentation about the Division of Technology

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Brochures, flyers and catalogs have been used as traditional promotional and informational materials for departments and universities. This presentation demonstrates a new form of promotion—the use of a multimedia CD-ROM that describes the programs housed in the Division of Technology at San Jose State University. This multimedia was developed by a team of students in conjunction with a faculty member and is used to present information about the undergraduate majors in the department. The multimedia development has undergone two revisions and is presently being beta-tested by the Division.

Our Involvement with 400 Multimedia Projects: Structuring the Process for Effective Learning

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The results of three years of multimedia assignments given to high school students suggest a high level of technical knowhow among all group members is less important than a full understanding of the process under which the project will be carried out by the team.

Specifically, students made strong use of templates for gaining control of a project. Templates in this study included teacher-prepared documents with 15 screens, embedded navigational links, and sample texts. The templates acted as an extension of the teacher, guiding the students into the use of a multimedia authoring program. For novices, the bulk of the work remained typing or cutting and pasting from a text document because the template could be relied on for its use of color, position of buttons, serial links, and placement of text on each screen. For experienced users, the templates could be readily modified into a more dynamic document with complex links and menu structures. Throughout this work, the teachers pushed the idea that if the writing were terrible, the overall project would not succeed as flashy media could not compensate for weak research and poorly developed ideas.

Second, students worked best when a team captain from each group was trained extensively in each technical skill and, in turn, taught the respective members of their teams the same skills. Groups functioned well when a division of labor took place among its members with responsibilities for sound production, scanning, design, final editing and beta testing. Most team members learned all of these skills.

Last, the teachers who set aside sufficient blocks of class time were more satisfied with the outcomes of the projects. A variety of techniques emerged to deal with procrastination and divisive team structure.

Preview of a Multimedia Textbook for CS1:
The Universal Machine:
A Multimedia Introduction to Computing

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Ironically, in current computer science courses, the computer is seldom used as a dynamic instructional tool. Although many texts now include a floppy disk containing problems or programs, the usual work disk barely scratches the surface of what a computer can do to present multimedia instruction. Multimedia can far exceed the capability of a textbook, using a personal computer to present materials that are beyond the scope of text. Moreover, hyperlinks and indices facilitate non-linear exploration of concepts, encouraging students to learn on their own. In addition, multimedia can provide a more congenial environment for those students whose learning styles lean more to the concrete, participative approach, rather than the typically more abstract, reflexive approach of most programming courses. We believe the substantial multimedia component of our forthcoming CS1 textbook--which we demonstrate--will offer a number of novel educational advantages, both to teacher ans student.

ORWelt - A Hypermedia Learning Environment for Operations Research

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ORWelt is a modular hypermedia system supporting business students in learning Operations Research (OR). The ORWelt project was started in response to the significant need for educational software expressed by OR-teachers and students.

A core component managing navigation and administration was developed by researchers at the DS&ORLab while major subject and test modules were developed by students themselves.

All components are hyperlinked and provide access to a glossary. Navigational tools include a graphical browser for structural orientation and direct access to components, user-defined bookmarks, annotations and full-text-search capabilities. Guided tours can be defined according to the needs of the individual user.

Small simulations and professional optimization software were included to allow students to explore the results of changes of parameters on the solution of presented problems.

Our current work focuses on including complex case studies with links to the methodical components to provide an alternative problem-oriented approach to the material.

Learning strategic management with NetStrat, a distributed business simulation

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As part of a project on instructional design for collaborative distance learning for the workplace, observations have been made on collaborative learning aspects of the learning of decision-making in strategic management supported by a computer-based business simulation. Teams are formed and given the task of making a series of decisions in a competitive business environment. After each round, results are computed and given to the students to guide their decision-making process. A Web-based distributed simulation called NetStrat has been developed to support telelearning situations, and will be demonstrated with on-line instructor and team.

Does Internet Communication Affect Performance? Some Results for Distance Learning Introductory Computing Students

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Abstract

The use of the Internet is a common theme in current educational technology research. However, hype does not augment learning, and new technology alone does not promise improvement. The question is does Internet presentation alone affect learning outcomes? This study examines two groups of distance learning students on a single course, (introductory computing) using the same learning materials, but with different means of communication. One group consists of conventional distance learning students who communicate with their instructors via telephone and written correspondence, while the other group communicates electronically via the Internet (this includes electronic tutorials and electronic assignment submission). Attitudes and average assignment grade are compared for each group to assess the impact of the Internet. The results indicate there is no significant difference in average assignment grade between groups. In this study the Internet is not found to have any significant effect on learning outcomes, as determined by average assignment grade.

Designing and Developing an Interactive Multimedia, Learn-by-Doing Simulation

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The Digital Communication Fault Analysis simulation is being used to serve the training needs of over 2000 NCR customer engineers (CEs). These engineers are responsible for traveling to customer sites where they install, diagnose, and repair equipment. This learn-by-doing simulation is distributed on CD-ROM along with "real world" documents that the CEs actually use in the field.

The virtual environment created in the simulation very closely mimics the real world environment of a CE. The learner begins in the District Office where the territory manager discusses the overall goal for a major network upgrade project. To complete the program the learner must successfully install and repair network equipment at twelve customer sites. Many support resources are provided to facilitate learning, including an electronic performance support system, video tips from experts, and mini-tutorial sequences.

To create this learning simulation an iterative, user-centered design and development process was followed.

MAESTRO: The Writing Process Tutor

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MAESTRO is an adaptive writing process tutor for high school level English instruction. It was developed for the Fundamental Skills Training Project, a research project with the goal of transferring advanced, adaptive training technologies to the public education sector. *MAESTRO* is a process-oriented automated tutor that follows a cognitive apprenticeship instructional strategy in the semantic domain of writing. The tutor is being tested during the 1996-1997 school year at 24 high schools and middle schools in five U.S. states: Texas, New Mexico, Ohio, New York and Pennsylvania. This demonstration will include: (1) a demonstration of all levels of the tutor; (2) an illustration of a typical session for a student using the tutor, including adaptive advice, tailored instructional modules, and real-life writing assignments of video, graphic images and readings that depict interesting and probable writing situations; and (3) an opportunity for hands-on experimentation with the tutor.

Developing Multimedia Programming for Upper-level Foreign Language Courses (Literature and Civilization)

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Because most multimedia computer assisted programs for Foreign Lanugages are targeted towards lower level language learning, first and second year, we are demonstrating two multimedia programs that are designed to meet the pedagogical needs of upper level literature and culture classics in German; Spanish. The Spanish program presents an overview of Nineteenth Century Latin American Literature and Culture employing segments of the film *Camila* based on a biography written during General Rosas' Federalist regime in Argentina and student made videos. The German program will focus on the works of Hildegard von Bingen, finally treating the trial in 1148 of Hildegard, a highly educated, medieval, mystic nun by the Archbishop of Mainz.

These projects have been developed on a Power Macintosh 7500/100 PowerPC using HyperCard 2.3, Quicktime Tools for HyperCard, Apple Video Player 1.3.1, MoviePlayer 2.5, MovieCleaner Lite 1.2, BigSound version 1, an Apple Color I Scanner, HyperCard Color Tools, Microsoft Word 6.0.1, and a CDR-CD burner. We felt the Power macintosh is advantageous because it is a multimedia machine with most of the needed technology built-in. The HyperCard program is simple and inexpensive to use, and compatible with the Power Macintosh. Both sound and video movies were created with the MoviePlayer program. Sound movies were created initially using BigSound. Using MoviePlayer, BigSound files were later converted as QuickTime movies. Sound files were installed into HyperCard "as is." Videos were recorded using the Apple Video Player, and compressed using MovieCleaner Lite to save memory. Images used in these programs were scanned on the Apple Color I Scanner, saved as PICT files, and placed in the HyperCard stack using the HyperCard Color Tools. When our programs were satisfactorily completed, they were saved on a compact disc using a CDR CD burner.

"*CyberRecess*^{TM} - The Development Of A Dynamic, Contextual Application For Enhancing Learning Through User-Driven Authoring Using The Internet."

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CyberRecess^{TM} is a multimedia educational application, designed for children from kindergarten to grade 12 (K-12), in which the setting of a particular context is used as the basis for the creation of dynamic, user-driven content. Based on a learner-centred model and constructivist principles, *CyberRecess*^{TM} empowers and challenges the student to engage in active learning. It is an application with a key difference! *The content is entirely generated by users for consumption by their peers.* Students effectively become publishers and, through communication with "contextual editors", they can shape the design and development of future contexts so that relevance of the application is assured from a user point of view.

CyberRecess^{TM} has six basic sections based on Science, Mathematics, English, Art, Humor and the "*Wired Goose Chase*"- a section that allows for the development of online research and navigational skills. Any student with Internet access can participate in *CyberRecess*^{TM}. Submissions are screened and qualified by a team of editors and selected entries are posted. The experience is truly empowering as every child is presented with the possibility of authoring, publishing and sharing their work and experiences with other children elsewhere.

Using Educational Technology in Discovery Learning

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Discovery learning is a constructivist method of education in which students work in collaborative teams to solve problems. At Augusta Technical Institute we have developed a model for discovery learning in the community college environment. Our model consists of 3 major foci: communication, information utilization, and collaboration. Central to this model of discovery learning is the appropriate use of educational technology to improve the richness of information available to the student and to enhance the problem-solving process via computer-based simulation and asynchronous communication.

Communication includes e-mail and web-based conferencing. Information utilization emphasizes on-line search strategies and ways to analyze the resultant data. At the end of each problem, teams share their problem-solving strategies with the entire class. The details of a biology curriculum unit will be presented. This problem-based scenario involves an inherited genetic disease and incorporates elements of genetics, cell biology, pathophysiology, and ethics.

The Information Superhighway and Telecentres in Australia

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Abstract: This paper explores the inception, development and ongoing battles of telecentres (telecottages) in the Australian context. Australia, the island continent, is among the most urbanised of countries. Its vast geography and habitation patterns present fundamental problems for policy makers in the telecommunications field. The myriad recent developments in telecommunications, computing, broadcasting and publishing industries present technological solutions to some of the perennial problems faced in the rural and remote areas. Telecentres are examined with a view to judging their potential to service the populations in these regions and to see if the information superhighway holds any allure in such developments. The place and role of education in the telecentres' operations is investigated together with an exploration of the pressures that the telecentres are under in their efforts to remain viable.

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iDEANet - An Exploration of 'Poly-Media':- the Potential of Compressed Video Television in Distance Education.

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This paper draws on path breaking experimental work conducted by the author which combines broadcast television with computing, and video and audio conferencing. The paper takes a 'what if' approach to show that this is a low-cost alternative for interactive distance education. The suggested configurations can be replete with high-technology aides or can be streamlined to suit the purpose of the educational endeavour and scaled back, where necessary, to match the existing information and communication infrastructure. The paper will draw on the original 'poly-media' configuration trial and the presentation, which is intended to be interactive and collaborative, will consider further hybrid application of the approach.

Testing by Doing: A Case Based Approach to Testing

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A computer assisted system for testing professional proficiency in psychology was built by using the cognitive principles of Intelligent Tutoring Systems design. This system combines the main advantages of the existing approaches for testing which are: written multiple-choice xaminations and oral panel examinations. Therefore, the system is aimed to be, capable of computer scoring, standardized, bias free, and ecologically valid. These goals are pursued by computerized psychological simulations where the psychologist may search for relevant information by asking simulated persons, to relate the intake information with the relevant diagnostic classification system, planning a treatment, and, evaluating the effect of the intended treatment on simulated prognoses.

MERIMNA: An Interactive Multimedia Learning Environment in Bookbinding for Mentally Handicapped People

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In this work we present a fully interactive computer based training tool in bookbinding for mentally handicapped people. MERIMNA is an easy to use multimedia-based system providing training over a LAN to mentally handicapped people. The system contains several training courses, depending on the level of the mental disability of each trainee. The courses have been designed for disabled from the age of sixteen to thirty. They aim in providing vocational training for their integration in the normal way of life. The teacher is able to keep track of each student's performance and to adjust the lessons series according to his/her improvement.

A Process Oriented Evaluation Model for the Learning Enhancement Envelope (LEE) Projects

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The Advanced Education and Career Development ministry of Alberta allocated a total of $30 million over three years to be distributed through a Learning Enhancement Envelope to higher education institutions for the purpose of expanding opportunity, improving learning and increasing productivity. The Lessons Learned (LL) project at the University of Calgary is a mechanism for communicating the challenges, approaches, and results of the Learning Enhancement Envelope (LEE) projects within the university, to other Alberta higher education institutions and beyond. Projects currently under development encompass a variety of disciplines (for example social work, medicine, art, history) and consider a wide range of technologies to support learning and teaching, including web-based course delivery, videoconferencing, CD-ROM development, simulations, and CAL. A repository of information designed for interactive case based *lessons learned* will be integrated with an automated management system. The design for this system is based on the learning and instruction development sub—committee toolbox also known as LIDS—TB (Gaines, 1997), and draws on work in interactive case based approaches to instruction (Dobson, 1997). This session presents a work-in-progress demonstration/discussion of the application of a process oriented evaluation model used by the LEE project teams. The evaluation model is based on the idea that evaluation is an integral part of the design—development—implementation—evaluation cycle. Emphasis is placed on use of direct interviewing and observations of students in order to gain insight into the qualitative ways in which students are thinking about materials they are learning as well as the learning approaches they are taking in approaching the materials.

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Creating Multimedia Environments to Support Collaborative Learning

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Abstract

Learning is an inherently social process. However, the use of multimedia is quite often refined to support individual learning processes only. As a consequence multimedia ist often regarded as a means to replace social learning settings by individual learning activities or tele-learning. In our research group "Computers and Society", we follow the opposite approach. We have created a learning supportive infrastructure to study how best social learning processes can be supported by the use of multimedia regardless whether it is tutorial, seminar, lectures or individual learning. We distinguish four different areas where support of collaborative and social learning processes can take place. This paper describes the typical problems which arise in these four areas and discusses our ways to solve this problems.

Cooperating Virtually about Virtuality: Promoting interdisciplinary Efforts

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We will present our proposal software for an interactive media which supports interdisciplinary-based Computer Based Education (CBE). Given our fast-paced workstyle, it becomes hard, if not impossible, to negotiate continuous, long lasting design meetings with several experts. These experts are faculty from diverse schools in our campus who contribute to the virtualization of a course. It has been proposed that the Internet become, using *Collaboratories*, a preferred means for bringing together people into the course redesign process. We have chosen to use the Java technology as a tool for the implementation of such a Collaboratory. Our objective is to allow a flexible and distributed instructional design, which we eventually plan to convert into a CAVICE (Computed Aided and Virtual Instructional Course Engineering) scenario. The WWW is becoming a widespread tool within our academic community. We intend to contribute with a method for educational collaboration via the Internet.

Navigational Patterns in Interactive Multimedia

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Abstract :

The navigational patterns research paper commences with a critical review of work by researchers, interrogating the types of navigation patterns that they have identified, usually in hypertext or more rarely in multimedia.

After investigating these, some empirical work has been completed, allowing a series of navigational patterns for multimedia to be developed, which are both more comprehensive and recognisable from their present usage and for future work. These patterns are then tested further empirically, where the users navigational strategies are analysed in terms of these classifications, these are then represented with a description of each pattern, and are then related to those of other researchers.

The poster shows navigation patterns recognised (Chart 1) and my navigational patterns with descriptions. The full research paper critically analyses these and relates them to the empirical work before producing some conclusions on how these navigational patterns are actually being used in interactive multimedia.

Internet-Based Earth System Science Instruction

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Demonstration Details

Increasingly, K-12 teachers and students are surfing the Internet in search of images, information, and ideas that support and extend their educational objectives. Unfortunately, what they are finding is that the resources they seek are often scattered across hundreds of databases, home pages, and documents. Furthermore, most teachers and students have no clear idea of how to incorporate Internet-based resources into normal classroom teaching and learning. Prototype K-12 classroom activities are needed that model the use of on-line images, information, and computational resources. In addition, these prototypes should model the integration of science, mathematics, and technology in contexts meaningful to K-12 students. In response to this need, the Network Montana Project (NMP) is collaborating with teams of teachers, scientists, and mathematicians to develop Internet-based, K-12 classroom activities and related distance learning courses that integrate mathematics, science, and technology in the context of meaningful issues.

Designing Virtual Practicums for Pre-service Teachers: Three Project Iterations

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Abstract: This paper reviews the development of three Virtual Practicums for pre-service teachers over a 12 month period. The first iteration of the project involved matching more than 20 pre-service teachers at Massey University (Palmerston North, New Zealand) with 40 students drawn from the Nechako Electronic Busing Program TM and Sinkutview Elementary School (Vanderhoof, B.C.). This electronic project was delivered over a period of six weeks. A second pilot project explored the potential of Virtual Practicums connecting pre-service teachers from the University of Calgary with On-line Teachers from the Nechako Electronic Busing Program for a six week on-line teaching /learning experience with E-Bus families. Recommendations arising from this experience were incorporated into the Third Project, a full practicum offered during the 1997 winter term, connecting student teachers at the University of Calgary with On-Line teachers from the Nechako Electronic Busing Program TM .

THE RISE PLATFORM: SUPPORTING SOCIAL INTERACTIONS FOR ON-LINE INTERNET COLLABORATIVE TASKS

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RISE (Real-time Interactive Social Environment) is a generic platform developed as part of the Education & Training research programme at BT Laboratories. The first application of RISE is a World-Wide-Web (WWW) based system (called Merlin) developed in conjunction with Hull University, which incorporates an on-line English as a Foreign Language course, accessible from anywhere on the internet. It is the first of several Televersity applications that are being built using the RISE platform. This work is underpinned by a common learning framework developed by Terry Mayes at Glasgow Caledonian University. In particular it supports the view that dialogue is one of the keys to effective learning. Future educational systems must not only foster dialogue and be situated in meaningful tasks but also recognise that much of learning is a product of a social process resulting from learners interacting with each other.

Network - Based Learning and Future Educators

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Abstract

Terms such as the Internet and broad band have replaced CD - Rom and multimedia as this year's buzzwords. But the growing interest in communication systems is more than just a passing fad: it will change fundamentally the way many people teach, learning, and access information.

The educational potential of communications is huge, but there is some concern that in the rush to embrace the technology, many important issues are either being forgotten or over looked. There is little ability or effort to organise, contextualize and develop coherent educational experiences.

Educators will need support to learn how to take advantage of - end drive - the technological evolution of the Global Network.

The aim of our research is define the best way of use a medium in a given situation.

Key words: Internet, University Education, Case Study

Internet Broadcasting in Distance Education

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The British Open University currently has some 47,000 students studying courses which require them to have access to a personal computer. Of these, around 23,000 have modems and an increasing number have machines with multimedia components. The main teaching media of the University continues to be print and this is complimented by television and radio broadcasting, audio and video cassettes and computer-based teaching materials. An increasing use is being made of network services such as computer mediated conferencing and the World Wide Web to replace face-to-face tuition and to provide distance learners with additional resources in their studies. Internet broadcasting offers another complimentary teaching media for the University and a number of projects have been carried out to explore its potential for distance education. Internet broadcasts which are intended mainly for university staff are a natural extension of the organisational use of electronic mail, computer mediated conferencing and the Internet. Broadcasts of this type can be particularly effective because participants tend to have access to more network bandwidth in their offices than at home and it is this application which is likely to be

Sport Nutrition - Educating Athletes Through Multimedia

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Proper nutrition before, during and after competition is crucial to an athlete's success. Dietitians and nutritionists are the experts whom athletes consult; however, professional dietary advice is not always available when needed.

The Multimedia Sport Nutrition project examines teaching and learning models in the application of athletic nutrition. Traditionally, learning theories and instructional design practices have been developed which focus on a specific type of learner or method of learning. Classroom instruction is further bound by the teaching/learning style of the instructor.

One of the benefits of multimedia instruction is the ability to deliver instruction tailored to the learner's style, level of content knowledge and preferred mode of instruction. This project will examine the relationships between these factors and look at multiple presentation methods.

Development of Network based Shogi Learning Environment

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The information network has been researched as the effective and applicable technology. Many researches on educational system also attempt to extend the field of study from stand alone system to network based CAI system. As one of network based CAI systems, we are currently developing a network based learning environment called "NESSY" (NEtwork Shogi SYstem) for learning Shogi (Japanese Chess) game. NESSY supports a student to learn how to play Shogi game. NESSY provides plural learning modes for playing, watching and discussing Shogi game. The student can observe the progress of others' Shogi game in watching mode. S/he can also exchange views with others on Shogi game in discussion mode. S/he can learn Shogi through the above-mentioned experiences on NESSY.

Strategies and Assessment in Mathematics Teaching: Multimedia resources for math-education courses

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It is commonly accepted that teachers teach the way they were taught and that innovation is difficult to achieve. Teacher education courses often involve tasks that require students to process knowledge that is unconnected to situations in which the new knowledge will be applied. Consequently, the knowledge and abilities that are learnt have little chance of transfer to real classroom situations. In an attempt to overcome this problem, the theoretical framework of *situated cognition* or *situated learning* has been used in this project to design some interactive multimedia resources that allow preservice teachers to become aware of different assessment and teaching strategies in mathematics education and how to apply them. The resources enable users to encounter the authentic use of a range of assessment and teaching strategies and to view their interpretations from multiple perspectives which include the teacher's decision-making processes, the child's thinking, expert opinion and written documentation.

USING COMPUTER GRAPHICS and ANIMATION to VISUALIZE COMPLEX PROGRAMMING CONCEPTS

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This paper describes the "C-book" software development project. C-book is a computer aided teaching tool (CAT) for instructors of the C programming language. The tool provides graphics and animation allowing the instructor to visualize complex lecture concepts. Related literature has shown that visualization is a highly effective pedagogical way of transmitting information, and C-book reflects in this area.

The Hyper Resourceful Syllabus and Its Contents

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Instructors everywhere are beginning to appreciate the Internet. Indeed, they are not only going "online" in droves, but many of them are going positively "hyper." They are designing indispensable hypermedia and multimedia resources that deliver course readings, lectures and assignments to students -- wherever they may be -- at the "click of a mouse."

One can "stay current" in one's field through regular e-mail correspondence with friends and colleagues all over the world, while "going future" with the help of numerous generous academics. One can access the ongoing work of instructors who take the time to list their course syllabi at the World Lecture Hall, and there is a growing number of institutions developing online teaching centers as well as online or "Web assisted" courses.

Education will continue to be mediated by computers and other technologies. Instructors who have the skills to put their syllabi in cyberspace, to develop resourceful and interactive Web pages with scripting languages (such as Java or Perl) or multimedia programs (such as Authorware or Astound), have a real edge. Not only have they already rewarded their students, their colleagues, and their institutions with their hard work, but they have begun to prepare themselves for the future of education and their place in it.

A Windows-Based Automated Sports Carnival Management Tool

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Sporting carnivals at schools require enormous amounts of time and effort to plan and run. An automated system would greatly reduce the workload and provide a simply modified and used system. A prototype automated system has been developed and is currently the subject of beta tests at certain West Australian school events.

An automated solution to carnival information management needs to address key areas such as time scheduling in order to reduce the planning and running stages of the carnival. This software tool attempts to help in three main areas of the entire process; planning the events, placing competitors into events, recording and tallying results. An automated solution has necessitated the construction of a competitor database.

The *Automated Sports Carnival* has been developed on an IBM Pentium 100 computer and will run under Windows 95. The project is undergoing feedback and review at the moment. However, it is hoped that a commercially viable product will be available in the near future.

Interactive CSCL System Based on Three-Dimensional Shared Space

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We focus on three-dimensional computer graphics (3D-CG) and animation technology as a educational tool for Computer Supported Cooperative Learning (CSCL). Although some experiments using 3D-CG in educational fields have been reported, most of those systems are of the stand-alone or pre-downloading type. We have developed an interactive and cooperative educational system using 3D-CG, which consists of several clients used by students and a server managing the status of educational materials in a virtual classroom. Each 3D object is defined as a distributed object based on the CORBA[1] architecture to keep the status of educational objects in the virtual classroom consistent. The system allows several students in various locations to cooperatively manipulate any object in it and to create a new one. By interacting with the objects and each other, the students can intuitively learn about a wide range of phenomena.

[1] Common Object Request Broker Architecture defined by the Object Management Group.

Together on the Web

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Collaboration among students and teachers created a Web site for Florida's Altamonte Elementary School. University of Central Florida students, whose teaching strategies class met on the elementary school's campus, teamed with small groups of elementary students, guiding the 19 Dream Teams through the development of their Web pages. The university students received instruction from the UCF Curriculum Materials librarian in using web-authoring software, Claris Home Page. A microcomputer applications class at Point Park College in Pittsburgh objectively critiqued the home pages, following a rubric developed by the UCF professor and librarian. The PPC students benefitted from the data communications aspect of the project. Three goals were realized: exposing preservice teachers to outside collaboration's benefits; sharing teaching and learning in technology projects; introducing university and elementary students to planning, designing, building and publishing home pages on the Internet.

Exploring integrated audio/text Internet presentations in an educational context.

Gloria Jacobs, Joni Falk, Bridget Mooney, Jack Lochhead, Brian Drayton, Jon Obuchowski.

TEECH is an electronic community that connects leaders in the field of teacher enhancement. Over 600 projects that involve teacher professional development are currently connected on this site http://teech.terc.edu/ This site incorporates a searchable database, active discussion groups, papers on various topics and a lecture format which includes RealAudio as well as graphics and overheads.

In the context of this large, quite diverse community of leaders in the field of professional developments, we have been experimenting with the use of Real Audio and assessing the value that is added by bringing sound to the very visual web. We have experimented with using this technology to bring "virtual lectures" and "virtual panels" to our community. This provides a shared experience for a large group of people who would not generally have access to the same lectures.

Our primary question is how can RealAudio most effectively be combined with existing resources? What value does voice add? How can it be most effectively presented?

We have experimented with several modes, and we present the results of a comparison of them with a focus group of teacher enhancement professionals. We have used two kinds of material: presentations to conferences, and discussion sessions. We used them in the following combinations: Audio only, audio synchronized with the slides used by the speaker during the presentation, and audio plus the transcript of the address. Each of these has advantages and drawbacks, which must also be considered with reference to the labor required to prepare the Web presentation.

artNtec: Perspectives from WWW Users and Designers on Interface, Metaphor, and Content

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artNtec is a pointer to architectural CAD resources on the Web. The goals of *artNtec* are twofold. First, it is designed to compare user preferences on four different interfaces (outline, text with hotlinks, icon, and graphic map) for WWW documents. artNtec uses four different menu choices to present the same contents. Secondly, artNtec is designed to utilize content sensitive metaphors (in this case, floor plan metaphor) to help elicit their functional mental models when navigating through different sections (using rooms metaphors such as gallery, library, learning center, studio, guest room, and market place).

artNtec was published on thc Web to a small amount of users. Architects visited *artNtec* tended to like the visual presentations (e.g., floor plan interface), even though it took more time to download the graphics. Non-architects, on the other hand, tended to prefer "outline" interface for efficiency reasons.

In addition to on-line survey, the author of *artNtec* also interviewed web users and designers in various skill levels to report on different perspectives of how on-line materials should be designed and utilized.

SAEBIT : Multimedia Authoring Tool for Educational Software

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The necessity and effectiveness of using multimedia in educational environment is increasing. According to the requirement, many multimedia authoring tools for CAI program have been developed. But since most of the tools are for professional programmers, the tools that can be used by instructors in classrooms who are not good at programming are needed definitely. To resolve this problem, we developed a multimedia educational software authoring tool, SAEBIT which helps instructors in classrooms to make educational programs easily. This paper presents a CAI program model, the structure and the functions of SAEBIT which have been distributed among about 10,000 schools in Korea since 1996 March.

Collaborative Electronic Learning

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Funded by the Canadian Cable Labs fund and Shaw Communications, this project examines learning models using electronic collaboration when age and gender are masked. Three geographically and economically diverse schools in Calgary are currently participating. A computer network links the three schools, The University of Calgary and Shaw Communications. Students range in age from 9 - 14 years. Identified to other participants by only a pseudonym, the students share scientific data within groups that span three schools.

Phase One was directed toward establishing the communications protocols and installing and learning the email, bulletin board and video-conferencing software that could enable students at different locations to collaborate on environmental science projects. Phase Two will start this fall, with students writing, editing and performing interactive cross site television broadcasts. The effects on learning will be observed in both phase one and phase two.

A Pan-European ATM-Based Teleteaching Experiment

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A teleteaching experiment including four classrooms at different European universities is conducted over two semester periods. During Trial 1a course on "Teleteaching via ATM-networks" has been given which covered the networking prerequisites of the trial and the teleteaching application proper. The four lecturers used the CSCW tool ISABEL offering audio, video, viewgraph presentation, telepointing, teledrawing and session control. Feedback from the students has been obtained by evaluating questionnaires filled in after each lesson. Based on this input Trial 2 is prepared. In terms of equipment it differs from Trial 1 by introducing seperate audio/video streams which exploit ATM connectivity without using IP encapsulation. Greater network efficiency and better grade of service is expected. Further improvements are expected from precise guidelines for the preparation of courses and course materials. As the feedback of the students did not always unambiguously distinguish between drawbacks from the technological or the pedagogical aspects of the trial, an improved version of the questionnaire will be prepared.

The Canadian Visual Arts Information Network Student Interactive Imaging Program

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The Centre for Contemporary Canadian Art (CCCA) is developing the Canadian Visual Arts Information Network (CCCAnet) based on a database of information about contemporary Canadian artists, with digitized images of their work. To build the database the CCCA established the Student Interactive Imaging Program which engages high school students in the digitizing of images, interaction with practising artists, and the development of a web site. As a learning activity, both the development and the use of the Canadian Visual Arts Information Network is a rich, multi-faceted environment that promotes many effective learning principles. The CCCA's on-line database is based on the Multi MIMSY 2000 Information Management System developed by Willoughby Associates of Winnetka, Illinois. To add a further interactive component to CCCAnet, the CCCA is experimenting with JETS, a Java-enabled 'TeleCollaboration System' designed for the real-time sharing of Java applets software, which has been designed and developed at the Multimedia Communications Research Laboratory at the University of Ottawa.

The Role of the Computer Science Department in K-12 Education

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Leaders in industry and state government are committed to equipping the schools in New York State with the technology needed to join the *National Information Infrastructure*. The Computer Science Department has taken on the role of helping teachers navigate the technology hurdle, encompassing exposure, evaluation, collaboration, integration and dissemination. Teachers are often overwhelmed by the hype that surrounds the selection and integration of the new technology. Computer Science faculty, who both understand the technology and are familiar with classroom teaching methodology can guide K-12 teachers through the decision making process. Formal courses and workshops have been utilized to aid in the integration of technology into instructional practices of public school educators. Curriculum specialists exposed the teachers to current software packages, which stressed a thematic approach to Social Studies and Language Arts. Other experts explored computer software for problem solving in mathematics and a hands-on discovery approach to learning science.

Multi-user, Interactive Concept Mapping Tools for the Learning Web

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The demonstration compliments two papers in these proceedings: Rob Kremer, "Multi-user Interactive Concept Maps for the Learning Web", and Roberto Flores-Mendez, "Java Concept Maps for the Learning Web." The demonstration will show several different concept mapping tools developed at the Knowledge Sciences Institute at the University of Calgary. The demonstration programs allow users to create, edit, and store graphical concept maps using a direct manipulation user interface. Users can easily re-arrange nodes in a map by using the mouse to "drag" nodes around the display surface. Arcs are attached to nodes by drawing or dragging their endpoints onto the nodes. Arc endpoints automatically move to follow the nodes they are attached to. These features combine with other direct manipulation features to provide a simple and intuitive interface for concept map editing.

The Engineering CALGroup.

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Engineering CALGroup is one of the Projects set up and funded under the Teaching and Learning Technology Program (TLTP) in 1992 to create Computer Aided Learning material for engineering undergraduates in a variety of disciplines. CALGroup have produced over 60 modules covering topics in electrical and electronic engineering, mechanical engineering, thermodynamics and fluid mechanics, design, manufacturing and mathematics.

Most of the material is aimed at first and second year students. Much of it is also suitable for foundation year students. It is anticipated that its main role will be to supplement lecturers and assist in achieving a consistent level of subject coverage across a class. It is also popular for revision purposes.

This demonstration will showcase the suite of CAL material produced by the Engineering CALGroup, a consortium of UK academic engineering departments funded under the TLTP programme. Delegates will be free to try out the CAL modules and information on the material and the CALGroup User Club will be available.

For additional information email: calgroup@cbltech.demon.co.uk

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PAYING ATTENTION TO MULTIMEDIA: LEARNING FROM THE DUAL CHANNEL INTERFACE

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Evolving hardware and software attributes will surely permit users more adaptive and nonlinear interactions, and a higher capacity for differentiating audio and visual presentations. Moreover, researchers can't always find reliable information on how to focus human attention on competing tasks in contemporary interactive programs and online services. This paper introduces the SSF Model for assigning structural and functional attributes of audio into educational computer programs. The SSF Model is comprised of two operations: 1) assigning functions to the auditory events; and, 2) structuring the auditory events with co-existing visual objects. Although this model can be applied to any didactic or interactive learning environment with audio digitizing or synthesizing attributes, its application should be selective and fully integrated with current theory and exemplary practice. While the model may not be ideal for applying sound to visuals, recent findings in some educational settings suggest a better-than average probability of success.

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Applying Education by Design in Distributed Hypermedia Environments

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Distributed hypermedia environments, which presuppose a distributed representation of knowledge, integrate hypermedia systems interactive features with computer networks. By combining these two systems which have proven their effectiveness for educational purposes [Barker, 1996], [Cohen, 1996] distributed environments may be an efficient way to encourage learner-centered education, aimed at a more effective learning process.

This work has been developed at University of São Paulo for our undergraduate courses. The primary objective is to provide a collaborative, experencial, active and multisensory learning. We have made use of learning by design [Shepard,1991], through which students may learn by developing enticing projects of their own interest. These are projects and subprojects jointly developed with or supported by instituitions within the community, in which students will put the concepts assimilated into practice. While working to shape ideas, students develop their different skills [Gardner, 1993] to overcome difficulties in making such ideas feasible, thus constructing knowledge.

Axiomatic and Ancillary Use of E-mail in Preservice Education Courses

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Drawn from their personal experiences, the authors describe how they each have used electronic-mail (e-mail) in different ways for different purposes.

Hedrick uses e-mail as an axiomatic tool in a field-based reading course. Students spend most of course time tutoring elementary students. E-mail is a vehicle for peer-to-peer conversing about problems, concerns and successes. Student -instructor e-mail is an invaluable and private consultation medium. E-mail is a critical and central tool in tying together field experiences and course learning.

McGee uses e-mail as ancillary tool in a field-based elementary teaching method's course. The class meets weekly and students spend 25 hours in local schools observing and teaching. Student send reflections via e-mail and then are given a variety of opportunities for other tasks. Although not a critical component of the course, students use the medium in a meaningful way and begin to value the function of e-mail as a tool.

Interactive User Configurable CAL . A Working Example in Epidemiology.

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We have produced a teaching package for Epidemiology, for which a major design goal was the provision of a major degree of end user configurability. This allows the teacher to incorporate their own epidemiological data sets, additional subject modules, interactive question and answer sessions and external software links within the package. The structure and flexibility of our package is based on linking three distinct software components. The first is the user interface and the interactive exercise sections, which are written in Visual Basic. These exercise sections can be linked via DDE to a hypertext program, and from within both programs, links are established to conventional help files which act as a glossary. The programs menu bar also links to an MCQ program. While the package is a complete piece of courseware, the teacher can configure the presentation and content to suit a range of users and their own areas of interest and expertise.

The Internet - Communicating, Accessing & Providing Information: An On-line Web-based Course

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Abstract: This paper discusses the development and delivery of an award winning credit course: *The Internet: Communicating, Accessing & Providing Information* (Montgomerie & Harapnuik, 1996) which is delivered completely over the Internet. Since May of 1996 over 200 students have completed this online course. The paper provides a description of this course as well as a set of observations and recommendations for the development of future courses. After a discussion of the development of the course, the philosophy of the course is presented. A discussion of the structure of the course includes the instructional design, an acknowledgment of andragogical principles and the support for multiple methods of learning as well as a discussion of the technical details of the course design. Finally, a set of observations, suggestions for improvements and recommendations for future course development are provided.

Using a Wearable Computer for Mobile Training and Performance Support

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For training to be effective, it should be consistent with several challenging guidelines. These guidelines include:

- Give training when the learner needs it.
- Give training where (physically) the learner needs it.
- Train the learner on only the information that the learner needs.
- Allow the learner to control the training.
- Use the medium (e.g., text, audio, drawings, video) that most effectively communicates the information being learned.
- Emphasize performance rather than knowledge.
- Shorten the time between learning and application.

We combined a wearable computer and an electronic performance support system (EPSS) to give mobile users the training and task support they need, when they need it, where they need it, under the users' control. Our system also eliminates the gap between learning and applying skills. The computer includes a head-mounted display, earphone, microphone, wireless network, batteries, and voice-recognition software. The EPSS includes helpful multimedia information.

An ITS on the WWW with Interactive and Adaptive Courseware

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We have developed an intelligent tutoring system(ITS) on the WWW called CALAT which is presented in ICCE95 and WebNet96. The system consists of an WWW server on which ITS process runs for each individual student.

The current implementation supports the individual adaptation capability with which appropriate courseware pages are presented by analyzing the user's answers to the exercises, progress speed, and other characteristics. Interactive simulation has also been implemented in which target(simulated) environment is defined as a state transition machine executed on the server.

In this demonstration, following new features of CALAT will be exhibited:

- an adaptive HTML-based courseware utilizing existing HTML documents as an ITS material.
- an interactive simulation environment implemented with simulation engine written in Java applet running on the client.

These features are intended to utilize the standard data format, protocols, and software platform, so that the courseware design flexibility can be maximized.

ADAPTING MULTIMEDIA TO THE WEB FOR USE IN INTERNET-DELIVERED COURSES

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Over the years, problems inherent to the quality of distance courses have become well known--lack of interactivity, lack of collaboration, and lack of interpersonal communication to name a few. Although the Internet delivery method has helped resolve some of these issues, much work remains to be done. Stated another way, Sherry (1995) writes that the following components need to be present in any successful distance course: interactivity; active learning, visual imagery, and effective communication. This poster session will demonstrate how Asymetrix Toolbook II and other similar software can be used to produce interactive multimedia files that can be accessed by students on the World Wide Web. Asymetrix Toolbook II is one new software product used to deliver sophisticated multimedia content on the Internet in several different ways: the traditional file downloading, using a browser plug-in called Neuron, hybrid HTML and CD ROM, hybrid HTML, Neuron and "smart streaming", and HTML/JAVA conversion from a Toolbook file. The well known technique of placing a file on your server and having your user download the file is an option. The disadvantages are the time required to download and that Toolbook is Windows-only software.

State University of New York Empire State College's The Writer's Complex

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Planned Demonstration:

We plan to demonstrate SUNY Empire State College's online writing center, The Writer's Complex. Participants will have the chance to work through its many rooms and comment on their experiences with this lab as well as other OWLS with which they are familiar. Participants can get a sense of the structure and underlying philosophy that went into the creation of the Complex. We hope to encourage additional, creative ideas for the use of this particular student-centered lab, and we hope to engage in a broader discussion about the use of an online writing lab as a structure for teaching and learning. We also hope, through our conversations, to foster collaboration among institutions through the vehicle of this online writing lab.

Travelling Buddies: An Internet Activitiy For Elementary Schools

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The purpose of this Poster Session will be to display an Internet activity within our local elementary school that has grown from a trial one year ago to an important part of the school curriculum. The activity involves travelling buddies, toy animals shared between classes around the world. The project started as part of a larger Travelling Buddy project organised and coordinated from Chisholm Primary School in the Australian Capital Territory. One class in our school hosted a buddy from Chisholm and created a buddy of its own, Frillbert, for the children at Chisholm. The children enjoyed sharing experiences with the toys through writing and e-mail and this provided an impetus for other teachers in the school to join in. As well as Frillbert, there is now Puddles the platypus from Year 2, Ozzie Roo from Year 2 and Connie Cockatoo from Year 3. The Booragoon buddies have now travelled to several schools and by mid 1997 should have been around the world and back several times.

The development of the Multimedia CAL System for Education in Japanese on the WWW

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It is of great significance for Japanese learners to have not only classroom lectures but also sufficient time to study by themselves. We have been developing an effective multimedia CAL system for learning Japanese on the WWW. Most works developed so far for learning Japanese on the WWW seem not practical because they are mainly composed only of texts. On the contrary, the proposed system incorporates voice sounds of native speakers and animations of Japanese writing to help learners study effectively and efficiently.

The demonstration will show an effective system for Japanese education on the WWW.

IMPLEMENTATION OF A DISTANCE EDUCATION PROGRAM LEADING TO A BACCALAUREATE DEGREE IN VOCATIONAL EDUCATION

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Distance learning is achieved by linking teachers and learners in different locations by use of technology. Cartwright (1994) believed that the three crucial components of distance learning are interactivity, multiple locations and synchronous or asynchronous time frames.

One of the present distance education programs at the University of Arkansas, Fayetteville, offers teacher education classes for community college technology instructors. The distance education program is based on the Fayetteville campus of the University of Arkansas and connected to six university and college campuses. The goals of the distance education program are to help participants develop improved teaching skills and achieve a baccalaureate degree in vocational education. The participants are full-time instructors at twelve community and technical colleges located throughout Arkansas. All participants enrolled in the distance education program have worked in industry but have not completed college degrees or taken educational courses.

Information Technology: Subject and Tool in Mathematics and Science Preservice Courses

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This session highlights projects using telecommunications in preservice teacher education as a tool for learning rather than the subject to be learned.

Learners in science methodology classes were introduced to instructional technology through instructional modeling of databases, microcomputer-based laboratories, word processing, computer graphics, desktop publishing, hypermedia, and Internet as well as multi-media presentations. Further attention was given to directing students in the classroom application of these tools in a variety of content applications for the science classroom.

Telecommunications was used to manage three different preservice courses - a technology course, a mathematics content course, and a mathematics methods course. Courses had a World Wide Web home page containing a course syllabus, readings, assignments, and links to useful Internet resources. Students communicated with each other electronically using either a news group or e-mail. Assignments which could be submitted electronically were sent as e-mail attachments.

Studios for Inter-Institutional Collaborative Engineering Design

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The Realization Consortium is made up of five universities, Cornell University, Massachusetts Institute of Technology(MIT), North Carolina Agricultural and Technical State University(NCAT), Tuskegee University, and Worcester Polytechnic Institute(WPI) along with the Society for Manufacturing Engineers(SME). The goal of the consortium is to initiate a systematic reform of undergraduate engineering education by providing an opportunity for engineering students at all levels to design and manufacture products to meet customer needs (i.e., participate in the product realization process). To achieve this goal, the five universities have set up Design Studios.

The Design Studio at each of the five universities is interconnected for visual and audio communication, as well as the sharing of design data. All six Design Studios have some common hardware and software. However, each institution has developed a different configuration that meets its campus' needs. The Design Studios have been used broadly in two ways. At each institution, the studios have facilitated team projects and industry-sponsored projects with significant industry interaction. In addition, the studios have also been used by two multi-campus teams, to complete significant design and prototype development projects.

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Argumentation and Hypermedia

Curriculum Unit for Undergraduates

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Descriptive Overview :

This unit is designed for undergraduate students, and centers on the following aspects of public speaking: 1) topic creation and formation; 2) developing arguments for persuasion; 3) recognizing and analyzing arguments; and 4) organization. This instructional unit uses a database of propaganda analysis called *Powers of Persuasion*, and the program *Written Argumentation*, a tutorial on argument models.

This unit can be used either as a one-credit undergraduate course on argumentation, or as one segment of a three-credit course on presentational speaking.

Since most students do not find this subject intriguing enough for intrinsic motivation, other instructional methods to increase extrinsic motivation need to be applied. For these reasons, this curriculum unit incorporates hypermedia through including both instructor-based and student-based computer programs. The instructor-based program was chosen to allow students to experience a wide variety of "real-world" argumentation examples. The student-based program was chosen to allow students the opportunity to create and refine their arguments.

Using Technology to Practice Social and Emotional Intelligence

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The Cave Project is a multi-media, computer simulation targeted towards pre-adolescents that focuses on enhancing their social and emotional intelligence. Defined as the ability to understand and manage social relations as well as mastery of the self, social and emotional intelligence has been shown to predict success better than IQ. The social simulation that will be demonstrated, projected to be delivered via the Web and CD-ROM technologies, has the players in a MUD environment enter a three dimensional cave with four artificially intelligent, pre-adolescent avatars using NYU's Improv and FacePad technologies. They get trapped and attempt to escape the various rooms of the cave where they encounter emotionally intelligent challenges associated with self-awareness, managing emotions, motivating oneself, recognizing emotions in others, and handling relationships. How well the players navigate these challenges, as decided by a panel of psychologists with expertise in social and emotional intelligence, determines how fast the players escape the cave.

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Jump-Starting Web-Based Courseware Development

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The lessons gleaned from promoting the development of courseware web pages over the last 18 months are that to make rapid progress, a well-organised support system is required, driven by staff and early adopter faculty with hypermedia expertise, with student assistants available to carry out large parts of the implementation for non-technical faculty. computer and specialised media-handling equipment, and a variety of training and information sessions for faculty including a convincing argument for moving courses onto the Web. As well, to take full advantage of Web technology, classroom, network, dialup and public computing infrastructure should be in place on your campus.

Web courseware development can be effectively stimulated through funding competitions that accomplish several results: a) a sense of urgency to act is created by the temporary availability of funding and project support staff, b) faculty and staff brainstorm potential projects to prepare funding submissions, c) once projects are funded and underway and as the number of participants grows, a feeling of momentum develops that attracts the attention of other faculty who want to get on board, d) even those faculty who are not immediately funded are prodded into action when they see concrete evidence that courseware is not necessarily expensive or time consuming to produce. They then attempt to find creative ways to produce pages without central funding - for example through senior student projects in their courses. In our experience, the stimulus of central funding produces results far in excess of what one would predict.

Medicine and Multimedia: New Horizons for Target Population

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New technologies have not been intensively used to communicate with target people, mainly in the medical field. Updated health information for target population is an interesting area to join self-learning approach with user-friendly computing systems. High pressure is a common disease in 20% of the Brazilian population. So, we are developing an interactive multimedia to explain the main care with the health and it tries to answer the most usual questions about High Pressure. To reach the goal, we joined a multidisciplinary team: medical doctors; computing and education specialists and computer science specialists.

Our work aims to test new technologies efficiency as a communication channel to inform target population and to display information and orientation in kiosks at Brazilian public hospitals.

The prototype is now being tested with patients to improve interface and to make sure that the information displayed in the kiosk kits the medical goals.

Design of a Web-based Course on Comparative Advertising

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Introduction:

A series of book chapters developed by Gordon Hutchinson, who works in the Japanese advertising industry and DePaul faculty member Dr. Denise Nitterhouse examined the sociological, philosophical, religious and cultural differences that influence the design of advertising in Japan and the United States. An understanding of these differences would provide both clients and advertisers with a basis for creating and evaluating advertising campaigns for the respective cultures. Thus, Japanese companies wishing to advertise their products in the US would benefit from a better understanding of their potential American customers, and American companies would benefit from a better understanding of their potential Japanese customers.

Incorporating rich, detailed examples and non-examples of print and video advertisements from each culture was seen as an essential element in developing an understanding of the similarities and differences between these two cultures in the field of advertising. Thus, a collaborative effort by the principle authors and team members in the Academic Technology Development group, produced a prototype of an instructional environment for the comparison of Japanese and American print and television ads. The use of the Internet to deliver this combined text and image instruction was a key component of the design.

Web-based Quiz Using Cookies

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A multiple choice quiz was designed for delivery over the web and tested in a one day online contest. The quiz uses Netscape cookie technology to track users scores during a session even if they leave the site and return hours later. The system is unique as it allows casual use of the quiz by anyone on the web. Only those who register are tracked. The system is a simple model for online course delivery that allows auditing. Problems are discussed and solutions proposed for dealing with students participating in secondary school computer labs behind proxy servers. Perl scripts for tracking and displaying user scores in a database were developed. Other scripts track individual player's answers in separate user files. We show how these files can be used to grade users, to analyse quiz response and usage and to foil potential cheaters. Cross-platform issues, program structure and perl programming ideas are discussed in the context of the World Wide Web delivery medium used. The function and structure of the quiz system can be demonstrated online from any Internet-ready computer by visiting www.science.ca/quiz.

Internet Technologies:
A Nation-Wide Extracurricular Program for K12 Students

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Our aim was to test the feasibility of teaching Internet Technologies to K12 students from 4 schools around the country. Part of the work was done in the classroom, incorporated in the formal computer literacy teaching. We present the extracurricular part of the program.

The students' projects were related to various subjects like: video and audio on the net, Internet telephony, MOO programming, chat room building, 3D Worlds, VRML-based 3D structures, net viruses, connected devices, Java scripts etc.

We used a two-track tutoring approach: technical-consulting and administrative-monitoring. When needed, collaborative work was facilitated. We heavily encouraged the use of existing Internet-based resources, organized on-line events and taught them to make a technical presentation in electronic form.

We found that teaching Internet Technology at K7-K12 level is feasible and worthwhile and we recommend to implement this attractive and relatively cheap topic in technology education.

---

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Interactive Multimedia Applications In Second Language Learning

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This project combines the design of a course interface/demo with the conceptualization of a methodology for second language leraning on the World Wide Web. The intent is to use networked multimedia to better approximate an immersion situation via interaction with native speakers and access to electronic publications and environments produced in the second language. The model also facilitates individual learning and communication between teachers and students. Exemplary second language learning exercises currently available online were compiled for the course demo, to form a self-learning component of listening, phonetics, reading, writing and game play. Communication tools include access to e-mail, and computer text and viedo conferencing. Further resources provided are on online dictionary, a databank of student grades and assignments, and course information.

USING A MICROWORLD TO MOTIVATE AND ENGAGE ADULT LEARNERS

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INTRODUCTION

This poster aims to demonstrate a program written specifically to appeal to adult learners in a content area that is normally dry and unengaging. The area selected was a module on share valuation and investment. Traditionally this module is taught in a didactic fashion via lecture and seminar with heavy reference to the textbook. It was important to identify a means by which the information could be taught both to students on-campus as well as off-campus in remote locations. The major problem was how to incorporate the theory with practical understanding and application. The students also needed to see the impact which random events have on shares and gain feedback on their own share trading.

The microworld has been developed to accommodates eight motivational attributes of immersion; reflection; flow; collaboration; learner control; curiosity; fantasy and challenge. The microworld was designed to simulate a real investment house.

THE RELATIONSHIP BETWEEN STUDENT LEARNING PROFILE AND NAVIGATIONAL STRATEGIES IN A HYPERMEDIA ENVIRONMENT

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While hypermedia is quickly becoming a powerful instructional tool, research is needed to determine how individuals progress through the environment and make sense of the incoming information. This exploratory study examines whether differences in navigation exist among students of varying motivational and self-regulatory levels. Students in an undergraduate English course at the University of Texas read through a Web-based hypermedia program that focuses on the women writers of the Romantic period. The students completed the Motivated Strategies for Learning Questionnaire (MSLQ). In addition, the navigational trails of the students through the hypermedia program were recorded. Specifically, scores on the Cognitive Strategies sub-scales of the MSLQ (Rehearsal, Elaboration, and Organizational) were compared with the students' navigational paths to examine if any patterns emerge among students of varying self-regulatory levels. Building on the work of Pintrich and Garcia, student profiles on all Motivational, Cognitive, and Self-regulatory components of the MSLQ were generated and compared with the subsequent navigational paths.

A Learning Environment to Support C Shell Programming based on Multi-Agent

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Recently, various systems based on agent model architecture have been developed. In these systems, 'agents' with their own goals and functions are embedded, and perform their own tasks through collaborating among them to achieve a goal as the system requires. Using this agent model for the construction of educational systems, adaptive configuration of the system is achieved. The purpose of this study is to propose a methodology to design an educational system based on agent model architecture. In this poster, we explain the organization of agents to be executed as an educational system, and how to recognize the role of other agents necessary to interact with these agents in the educational system. As a case to show the organization of agents, we display the configuration of an intelligent learning environment to support C shell programming in UNIX. Moreover, we explain the collaborative behavior of embedded agents in this learning environment.

Considerations for the Development and Use of Educational Software

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Educational software should be inserted into a pedagogical project with well-defined guiding principles. Its utilisation should target the creation of an educational environment favourable to the construction of knowledge, allowing the access to information and the communicative interaction among the participants in the process. To achieve such goal, the cognitive development of the user and the factors capable of influencing the development ought to be studied.

Due to the emerging necessities of a world which gets wider, and under constant changes, the educational software must forecast into their interfaces, features that allow the access to information, distribution of the resources available in computer networks, interactive and reflexive communication, aiming the sharing of ideas and problems that the new generations have to face. In sum, the educational software has a social role to play. Therefore, its construction should have in mind adequate theories to contribute significantly to the new society.

HATHAWAY PRIMARY SCHOOL: A MULTIMEDIA CASE STUDY

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INTRODUCTION

'Hathaway' is a CDROM which provides extensive documentation relating to a primary school in Sydney's inner west. The school has a multicultural population (less than 10% of children speak English at home) in which the majority are Lebanese Moslems.

EDUCATIONAL USE

We have been using this material as the basis for an action research-based distance education course for teachers (around 200 each year). Our aim is to get teachers thinking about the complexity of schooling, the interactions between factors outside the school and inside the classroom and the nature of professional learning as reflection on action.

NATURE OF THE MATERIAL

The CDROM has been assembled using Supercard and contains more than 260 scanned images, 150 colour photographs, 30 minutes of full-motion video and two hours of audio linked to still images as well as many hundreds of pages of text. Currently it is available in Mac version only while we await the release of the Windows version of the software.

Innovative features include the linking of transcripts to video (especially important for NESB users but also enhancing the capacity of the material for use in research training) and the capability for students to assemble their own 'guided tours' through the material, incorporating links to particular pages, even to individual words. The material also has an extensive search/query function which provides students with navigational help.

The demonstration will consist of a thirty minute 'guided tour' through some of the most interesting pages as the basis for interation and discussion with the presenter, The tour will be repeated three or four times. Also available will be a handout giving important relevant information and access to a number of papers which provide accounts of research and evaluation studies related to the program.

Currently the CDROM is being used in our own courses and at a number of other universities in Australia, the UK, Austria, Norway and the US. Evaluation comments are being collected via the web site and access to this material will be available during the demonstration.

More detailed information can be found at the Hathaway web site:
http://www2.deakin.edu.au/sdg/hathaway/default.htm

Interactive WEB Language Learning

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What is language if one cannot interact with it? At best, interaction takes place directly with others who natively use the target language. However, language students can also cognitively communicate via the Internet by three convenient means.

Netforms

Netforms enables students to select among multiple choice answers and to interactively receive immediate feedback as to the correctness of the grammatical, vocabulary, or translation answer they have selected.

Frame Manipulation

The student can interactively apply language skills by clicking on (Frame) A or (Frame) B depending upon which frame, according to the student's opinion, provides the correct translation or answer, again receiving immediate feedback.

Image Mapping

If a student wishes to know the written and audio form of pictorially-depicted language, the student can click on the aspect of a drawing or picture which is to reveal the desired linguistic information and again interactively receive immediate feedback.

Comparing Multimedia & Traditional Instruction of Preservice Teachers in Modeling Whole Number Algorithms

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The National Council of Teachers of Mathematics recommends the use of physical materials to model procedures and link manipulation of these materials to the steps of arithmetic algorithms (NCTM, 1989). *Linking the Manipulation of Materials to the Modeling of Whole Number Algorithms* is a hypermedia program designed to help preservice teachers develop this skill. It contains multiple examples of modeling whole number algorithms with physical materials. Interactivity is encouraged through the use of menus and buttons for navigation, access to scope and sequence skills, and access to pertinent NCTM standards. It provides opportunities to describe the use of this skill in the classroom and to model algorithms by dragging manipulatives on the screen.

The purpose of this poster session is to demonstrate the software and present the results of a study comparing its effects to those of traditional instruction.

MULTIMEDIA INTERACTIVE LEARNING SYSTEM (MILS)

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MILS is not a teaching aid, it is a complete teaching system. It will take the student from one definable skill level to another and it is able to give all the necessary guidance and feedback. The system is a multimedia interactive learning and authoring tool.

MILS consists of four main modules: Contents Authoring, Exercise Authoring, Contents presentation, and Exercise Presentation.

. The Contents of knowledge in the MILS are presented with help of multimedia technology - pictures, sound, videos and text in an interesting way to attract the students' concentration. Students can review the contents anytime and select whatever they want to learn.

The Exercises are presented one after one and in three types of format: Multiple Choice questions, Matching questions and True and False questions. An immediate feedback will be given to students after they answered the questions.

TECHNOLOGICAL REFORM IN RUSSIAN UNIVERSITIES:

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Recent political changes in Russia have lead to radical transformation in educational paradigms. The term educational technology, in spite of its urgency is not expressively defined, therefore it is the subject of wide discussion. These new paradigms affect three aspects of the educational process: content, structure of programs and technology. Reorganization of the first and second aspects made after rapid social changes of the late 1980's and early 1990's has stabilized, and the development of content and structure, although slow, is extensive. The development of the technological component in education is the subject for intensive research and projects at Federal and regional levels. Utilizing computers to work with data bases, global networks, multimedia, and other software gives students and professors more opportunities to analyze information and to work with more complex decisions and problem solving. These multi-processes are important in all aspects of Russia's educational changes, and the technological direction is rapidly becoming a priority.

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